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THESIS

FUNCTIONAL MANAGERS' GUIDE TO INFORMATION SYSTEMS DEVELOPMENT

by

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Thesis Advisor: D.C. Guyer

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Functional Managers' Guide to Information Systems Development

by

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ABSTRACT

The development of large integrated information systems has had a spotty success record. This thesis investigates the role of the user-management team in the development of these systems and what principal problems the organization must face. The study recommends that the user is the individual with ultimate responsibility for the development of the system. Further the problems that must be faced, in descending order of importance, are 1) the organization power structure, 2) the people in the organization and 3) the technical issues of data processing.

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I. INTRODUCTION

A. GENERAL COMMENTS

The technology of computers has continued to evolve since the first commercial machines were built a mere thirty-five years ago. This evolution has contributed to the standard of living enjoyed in America today. Without computer technology it is unlikely we would have direct dial telephones, credit cards, our modern check-clearing system, fuel consumption monitors in our automobiles, or much of modern medicine.

Yet for all the good that has come from the computer it has been a mixed blessing. The machine that was to free the office of much of its drudgery has too often become the master instead of the servant. Many of the promises of automation have not been forthcoming, or have been partially filled leaving much frustration both for employee and the manager.

B. STUDY OBJECTIVES

This paper provides a guide for the non-data-processing manager for successfully obtaining a modern computer system. The approach used is based on the experiences of the author and others in obtaining an information system (computer, software, and operating procedures). Success is defined by

how well the system meets the needs of the organization and how little the organization is disturbed in the process of implementing it. The goal of the paper is to explain to the functional manager (a non-data-processing professional) what some of the trials and dangers are in the process of developing information systems. The technology of computers is well understood. The problems in implementing a new system are rather distrust and fear of computers, and of the dislocation of the social system of an organization that the new system could cause.

The process of obtaining a system is reviewed from the inception of the idea for automation to the successful operation of the new system. While the study will review general procedures, the reader's attention will also be drawn to those special activities peculiar to the Federal government and the U.S. Navy. The assumption of this paper is that the user-manager is not a data processing professional.

C. RESEARCH METHODOLOGY

The sources of data for this report are a literature search, user experience, the author's experience as both a user and manager of data-processing, and interviews with data processing professionals.

D. RESEARCH QUESTIONS

The primary research question is what guidance can be offered to assist a functional manager in developing highly

successful computer systems? The subsidiary research questions are:

1. What work must be done to prepare an automated system?

2. What key decisions must a manager make to ensure successful development of an automated system?

3. What management guidance is available to the program manager?

4. What considerations should be given to the peculiar environment of the office in successful system design?

5. What is the human impact of the system being developed?

6. What are the sociological impacts of automation?

7. How can the new system be successfully integrated into the office environment?

8. What are the key steps in the implementation of the new system?

9. What are the special security concerns of automated systems?

10. How will the new system be kept current?

11. What form should the system's support take?

E. THESIS ORGANIZATION

Chapter I defines the author's objectives and methodology. Chapters II through XI address each of the subsidiary research questions in the order presented. Chapter XII presents conclusions and recommendations.

II. ANALYZING THE PROBLEM

A. METHODS OF ANALYSIS

The start of any automation project should be to put all plans for automation on hold! Before any automation attempt is started there needs to be a thorough review to be sure that automation will help solve the problem, not just automate the problem. Technology should not be used as a cover-up for defects in the existing system, but rather as a device to move the organization toward better information management [Ref. 1].

The first question should be, "Are the current procedures and organization fundamentally valid?" The second question is, "Can automation be expected to make a real improvement to the current operation?" Unless both questions can be answered with yes then either the problem is not well understood or the current method should be improved before being automated.

Tools to aid the manager in answering these questins have been summarized by Chapanis [Ref. 2] into two categories: work measurement and job analysis. Work measurement or work study methods come from a variety of academic schools of training, from sociology to industrial engineering. These approaches are generally used to solve problems of physical layout, predict the impact of process changes, or identify

unecessary procedures. Work measurement includes three techniques.

The category of work measurement includes three techniques. Flow charting is a technique in this category. This method may be used to plot the movement of men or material and the communication links or time for each step. Flow charting works well in the study of forms processing, correspondence and report preparation procedures. Operational analysis, is used to identify and summarize the components of a work activity. This method is used at a much finer level of detail and is useful for studies like desk procedures to support an operation. In this category is the use of time and motion studies to determine standards or norms for processing time, for streamlining processes or staffing required for various parts of a procedure. Based on the author's experience, this is not of value in studying the operations of an organization engaged in office activities.

Job, or process, analysis is the term used to describe several of the approaches that use diagrams or representations to portray the sequence of the current operation. Job analysis places emphasis on determining what duties are associated with the job. Techniques include questionnaires, interviews, diaries, observation and activity sampling.

Questionnaires allow larger sample sizes and take less time than interviews. However, a properly designed questionnaire can be time-consuming and difficult to construct.

Interviews allow the study team to be flexible and to follow up on clues obtained in interviews to gain greater understanding of critical aspects of the job. A variation on this approach, the critical incident technique, attempts to identify those elements of a job that trigger certain activities from the employee.

Diaries attempt to develop a chronological portrayal of a job over a sampling period. Periods range from discrete time intervals, where every n minutes the employee records exactly what he is doing at that instant, to a log of all activity completed during a specified period of time. Observation may be in the form of an "insider" observer who becomes part of the work or group or an "outsider" who observes from a distance. Both attempt to identify what work is being done by the group and how it is being done. The results will depend greatly on the astuteness of the observer. The insider approach captures more of the subjective elements of an organization than does the outsider approach and can record events yielding more accurate data.

A straightforward approach borrowed from production management theory, which the author has found to be effective, is to draw a simple chart of the organization and a similar diagram of the physical location of the members of the organization. Several copies are reproduced of each chart, at

least one for each process to be reviewed. Then trace the flow of data through the locations of the employees and through the structure of the organization. If forms are used, one pair of charts is then used for each form. Loops in the process, time delays, and other anomalies are also noted on the charts. Most discontinuities in the process will be visible from the pair of charts. The next step is to develop alternative solutions to the problems uncovered. These can be shown on copies of the charts that indicate the problems. The alternatives should be discussed with the work force and supervisors to determine the reason for the current process and to develop better processes if possible.

Varying from these traditional approaches, Blumenthal [Ref. 3] admonishes that past efforts have tended to be too narrow in scope, consider insufficient alternatives or take too narrow a view of the organization. He suggests that a larger segment of the organization be reviewed to see the total structure of the problem and not just the area where the symptom is showing. If a department requests the study it will normally only be a departmental-size study, whereas the payoff might be in a change in another department that would benefit both. In addition, Blumenthal warns against developing a mental set that says everything must be done centrally.

Green [Ref.4] describes the office as a communication hub with a wide spectrum of activity, a diversity of people's skills, and functions and social orders.

1. The analyst should check for unnecessary steps and bottlenecks to be eliminated by answering the questions:

   a. What are the individual activities in the office?

   b. What are the activities performed?

   c. Who are the users of the activities?

   d. What is the frequency or volume of each activity?

2. For any averages developed, a central weighting factor needs to be carefully employed. At least a high-low and a normal estimate must be developed.

3. How much work can be done and, for a given amount of work, how much staff is needed?

4. In this process the analyst must carefully identify the real problems and seek a solution to them. The analyst must ask some questions that can and often do reveal the cause of problems:

   a. Is there an error in the analysis?

   b. Are the manual work flows or methods inefficient?

   c. Is the work force improperly sized?

   d. Is there a lack of controls or inputs?

   e. Is management inadequate or is the support system poorly designed?

Whichever of these methods is chosen, the objective is to define what is going on in the organization and office, define what should go on in the office, and establish what corrective action could or should be taken. If the choice is made to use automation, then the goals of the automation

should be defined. An open-minded review is an absolute necessity.

Once this analysis has been carefully completed, the manager must determine whether the problem is only amenable to an ADP (automated data processing) solution or whether other solutions or alternatives should be pursued first. If the organization is doing everything as effectively and efficiently as it can, then the answer may well be automation. But, if the analysis found problems in current procedures or organiztion, these problems must be corrected before any automation is attempted. Only after all the existing problems that can be rectified without automation have been addressed should consideration be given to automation.

B. INFORMATION ENGINEERING

The second phase of an automation project is to define needed improvements in specific, quantified terms. For that unfortunate manager who is placed in the position of being required to automate for reasons other than any real problem, this second phase will be his initial phase, since there is no alternative available to him. Before the desired information system can be designed, a thorough understanding of the problem is necessary if the solution is to be lasting and beneficial. To accomplish this, the organization must know its primary purpose. There needs

to be a clear, simple statement of why the organization exists and will exist in the future. This statement may be called a corporate plan, a mission statement, a strategic plan, or any other name, but it must document the purpose and direction of the organization.

One of several excellent methodologies to accomplish this important part is provided by Martin and Finklestein [Ref. 5]. They believe that the heart of the issue is the data that will remain stable while the organizational structures and procedures change. The information of the organization is for them one of its basic resources. They emphasize that as a business grows in size a division of labor becomes necessary. From this division of labor evolves a work force that does not know all of the components of the organization. This results in the need to communicate and in the natural growth of record keeping. As time goes by, these records diverge in content and meaning, creating problems for management and often leading, today to a call for a data processing department to fix the problem. The result is often simply faster problems with no solution. Thus, they believe that, to solve the problem, there must first be an understanding of the organization's purpose and what data is used to create the information needed to operate.

The recommended process is called information analsis. After the organization's purpose has been defined, the

requirements for each functional area are developed. The operational decisions, managerial decisions, policy decisions, and external reporting requirements are then identified. This analysis has as its goal to find all the various uses of the organization's data and to harmonize these uses for the whole organization, including future uses identified from the long-range plan that was the starting point of the study. Their approach identifies what information is needed, who uses it, for what purpose, why, and who receives the results. There is no need in their mind to spend large amounts of time and resources looking at current filing procedures.

This kind of analysis requires a new concept of who the analysts should be. The user of the information, the manager, operator, and the business analyst staff are the people who know what the purpose and plans of the organization are. The problem cannot be turned over to a data processing department with the expectation that they will understand the business well enough to derive the solution. Data processing's role in this process should be to facilitate, support, and learn about the organization, but the analysis is done by the manager, operator, and business analyst staff as a team.

C. SUMMARY

Whatever analysis method is chosen, there are basic goals that must be accomplished before any planning or solution

can be developed, let alone any actual work by a data processing department. Personnel outside the data processing department must be involved in the process. If they are left out, there is a very high risk that data critical to the success of the information system will be missed and acceptance and use of the ultimate system will be hampered.

During the analysis stage, one of the most critical pieces of information which is often overlooked until it becomes an expensive problem is how the exceptions to the routine procedures are to be handled [Ref. 6: p. 77]. It must be determined what, if any, range or limits are to be placed on the data and how these exceptions are to be handled.

Once the analysis has been completed, serious thought must be given to the alternatives identified. Management must ask itself if any solution is really necessary. If the answer is yes, then the second question is, "Can it be solved by making changes to the current organization or procedures?" If the answer is no, then the data processing alternatives must be examined in terms of their costs versus their related benefits, and the time necessary to accomplish them. After completion of the review again the question should be asked, "Is it necessary to do this at all?" If

the answer is still yes, then management must be prepared to commit time, money, and the best members of the organization to help implement the solution.

III. KEY ISSUES

A. PLANNING

A project manager will require two plans for an information system: a resource plan and a plan for the system design. The resource plan identifies the amount of time, the cost, and the people needed to complete the new system. The system design plan contains actual systems requirements and includes any partial solutions (subsystems that can be quickly implemented) that will have immediate payoff. The system design includes a plan for building the new system and converting from the existing system to the new system. It contains answers to the following questions [Ref. 7: p. 9]:

1. Should the development be done all at once or in phases?
2. Should some portions of any existing system be used?
3. Is direct terminal access to the system necessary "on-line" access or can batch processing be used?
4. Should there be one computer or several small computers?
5. Should there be one set of managers or several sets?
6. What computer language(s) should be used?
7. What types of quantitative tools need to be provided with the system? [Ref. 8: p. 102].
8. Which features are mandatory and which are merely desirable?

In addition to answering those questions, the system design plan defines the capabilities of the system in specific terms [Ref. 3: p. 5].

There are a number of pitfalls that need to be avoided in planning the new system. (1) Set the target times honestly; it is better to take more time and build the system right than to try to meet an artificially early completion date [Ref. 11]. If during the process of developing the system it becomes apparent that there was insufficient time provided, be willing to change and admit the need to change. (2) Do not try to be first with new technology unless you have the experts to implement it. Instead take a wait-and-see attitude toward new ideas, and use proven approaches. (3) Spend sufficient time, effort, and money to do a good job on the plan. (4) Expect costs to be higher than would appear necessary, both development costs and operating costs. Any ADP system by definition involves expensive machinery. (5) Take the time to do a cost analysis and develop a cost justification. If the benefits do not outweigh the costs, there is no purpose in building the system.

Defining the amount of computer support required is a technical task that should be performed by the ADP staff. The one concern that the manager must address is the amount of capacity that the computer has. It has been proven that, unless there is reserved, unused capacity, the system will

be more costly to develop, operate, and maintain than necessary. A rule of thumb is that above 70% of capacity there will be an exponential increase in cost, and above 50% there will be some increase in cost [Ref. 9]. Expect to see interference from unplanned sources that will detract from the resources that are provided for the project. You're getting the best people in the organization, if the organization is stronly committed to the project. Therefore, expect that some of these people will be required to respond to emergenices at times in the part of the organization that they came from. Plan for this.

Do not use new, special software provided by vendors without expecting trouble. New software always means extra trouble.

B. PEOPLE

People are the most important part of your ADP system. Without people willing to use the system, willing to create the system, and willing to exploit the advantages of the system, even the best system design will not provide the payoff that the organization is expecting. The people in the organization must be involved in the planning, the development, and the implementation of the system. They have the knowledge needed by the designers of the system. Involving these people will ensure that the system meets the needs of the user and that the user thinks it is his system once it is built.

In the user's eyes, the system must be a practical tool that he can use to benefit himself and the organization. The dialogue between the user and the system must be designed to encourage, not discourage, the user [Ref. 10]. If the system requires memorization of a lot of difficult codes, no matter how well designed, it will not be used. People do not remember the kind of codes that data processing likes to put into their systems. Place the difficulty on the designer and the developer and not on the user.

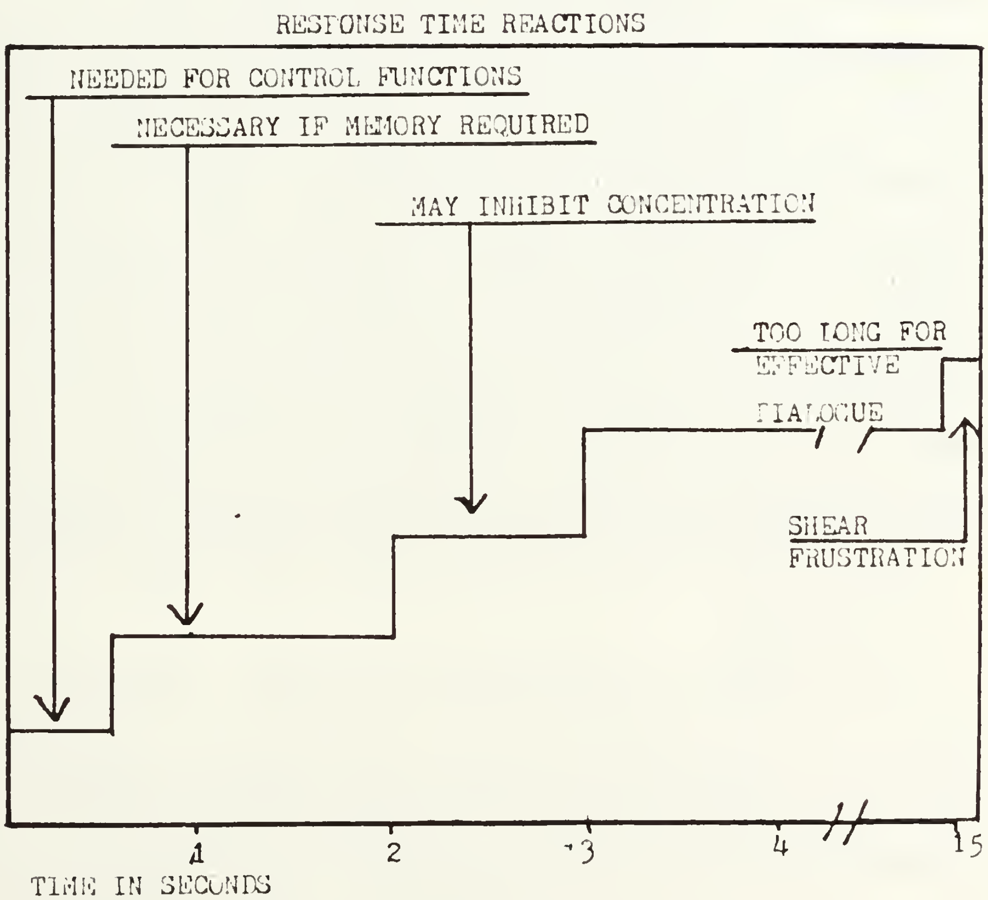

Figure 1. Response Time

There must be sufficient speed in the system's response rate to prevent the user's mind from wondering. Normally this is in the 2-3 second rage (see Figure 1). Even if the system is capable of a 2-3 second response on the average, if some of the responses take 10, 15, or 20 seconds the system is not properly designed, not responsive to the user [Ref. 10: p. 322]. The standard deviation of the response rate is the critical figure, not the mean response rate.

Prompts that correct the user's mistakes should be designed to be helpful, not intimidating [Ref. 11: p. 35]. In designing screen formats, it should be remembered that the human eye and mind are capable of absorbing only a limited amount of data at one time. Just as the telephone company limits the number of digits in a telephone number to what can be remembered, designers and developers of computer systems should remember that there are a limited number of facts that can be absorbed at one time. Therefore, screens should have a limited amount of data in them.

C. TECHNOLOGY

Technology is affecting us rapidly. New ideas are coming out of the laboratory at a faster rate and being implemented throughout this society at a faster rate than was true a decade or two ago [Ref. 12]. Furthermore, the rate of change caused by new technology is accelerating.

This rapid rate of change must be taken into consideration by the designer. A trade-off must be made between taking a new piece of technology before it is ready to use or waiting until it is too late and designing a system that is out of date by the time it is implemented.

D. ORGANIZATION AND MANAGEMENT BENEFITS

With any good information system there will be a tendency for the decision making in the organization to migrate upward. Supervisors within a well-designed system can expect to have more control over their operations as a result of the design. Employees can expect to be better able to handle the complex problems of their organization. However, this will only occur if the system is designed to keep the needs the organiztion and its people in balance. There are alternatives in any information system design. It can be designed so as to humanize organization or to dehumanize it. If it is designed to humanize the organization, the employees will support the system. If it is dehumanizing, reaction can range from dissatisfaction and frustration to sabotage.

E. USER

Many modern systems can be designed so that the simple questions that arise in an organization can be developed by the individual user into computer queries. Modern data base management systems have this query capability included.

It eliminates the need to have a computer programmer involved every time a new report is required of the computer.

In developing the design of the system, a statement of needs and requirements is the first phase in the data processing effort. During this phase, the user must be asked the old basic five questions: who, what, when, where, and why. This is a critical issue that must be addressed early in the design phase. The further into the process of design and development before the questions are understood and built into the design, the more costly it will be to include the solution to the users' problems.

The crux of the problem is that the art of computer programming is technically complex and syntactically confusing to a layman [Ref. 13: p. 1]. Moreover, the operational world of the user is equally complex and confusing to the computer technician. Therefore, the technician often doesn't understand the problem properly and the user never gets what he needs and wants. This results in confusion, frustration, delays, excess costs, and computers dictating policy, all because we are unwilling to spend the additional time and money to redo an important design [Ref. 13: p. 1].

F. SYSTEMS

If you plan to purchase software from an outside source, there are several things to remember:

1. Be sure your vendor is reliable and find out how stable his organization is and whether he is likely to be there when you have problems.

2. View his software package in use by another user at the user's location. Be sure that this user understands and can use the software.

3. Require the vendor to place the software code in escrow so that, if anything should happen to him, the software code becomes your property instead of his property. Then you can continue to exist even if the vendor doesn't.

4. In purchasing software, define ahead of time who will do any necessary modifications to it and what kind of response time to expect. In looking at any commercial software package, also keep in mind that, if it takes more than two days for the typical user to learn the basics of the system, it is probably too complicated and should be avoided.

Management should be involved in the decision whether to purchase or write software and stand by its decision. If the decision is to create programs within the organization, remember that you are building a one-of-a-kind product [Ref. 14:p. 9]. You cannot expect to proceed in the fashion in which Detroit or Tokyo assembles automobiles[Ref. 14]. The user cannot easily state his requirements in the language of the computer specialists, and the computer specialists will not be able to restate perfectly the user's requirements as he understands them in the language and the terminology of the user. Therefore there is inevitably a language barrier to overcome in the design of the system. There must be a continual effort to be sure that the ADP people involved in the design realize that the system is for the user's purposes and not for their glorification as technologists.

When asked to define their needs, managers often request everything. Serious questioning can determine just what information they really need. For example, a department manager does not normally need access to raw data from other departments [Ref. 15]. Information is the underlying strength of all forms of corporate power. Yet, an overload of trivia is costly both to the manager's time and to the organization. The productivity of the information process must be measured in terms of its contribution to the corporation; not in terms of its volume.

G. SUMMARY

1. Two types of planning are needed:
    a. Planning the development resources.
    b. Planning the new system.
2. The computer must have excess capacity.
3. People from the user organization must be involved in the effort.
4. Design the system for user's ease not the developers'.
5. The formats of data on the terminal should be kept simple.
6. Users at different levels of the organization have different information needs.

IV. MANAGEMENT OF THE DEVELOPMENT PROCESS

A. GENERAL COMMENTS

Contrary to many "horror stories" of new system design, a data processing organization, is not fraudulent by design. The stress in that statement, however, should be placed on the phrase, "by design," because in terms of total cost and delivered product, data processing frequently fails to measure up to its promises. There are two causes, neither of which is merely the fault of the data processing organization. First, the technology employed is still in its infancy, little of its potential is known; and few of its problems are understood. Second, the user is often the perpetrator of his own crime, either by ommission or commission. He may omit seemingly inconsequential details that are in fact critical, such as how to process certain data when it exceeds the normal range. Or the manager may fail to assign adequate talent to support the data processing team. Also, management may error in making decisions that are not their responsibility or not make decisions that are their responsibility.

A methodology has been developed that helps alleviate some of these problems. The traditional design approach was to develop independent systems for each of the various functions of an organization. The interrelationship between these functions and the data they used was generally ignored,

on the assumption that, if the independent units worked well, the total system would work well. This resulted in many problems. It was difficult to obtain all the information needed from the computer, because there was no way to assemble information from the different systems. Excessive costs resulted from duplication of processes and duplication of storage, collecting, and retrieving data. Data was inconsistent in time or perspective and did not have the same definition.

A reaction to these problems lead to the concept of developing one central system for all of an organization's data. Occasionally, these new systems were even provided with a query capability that allowed the user to access his data himself without having to rely upon programmers to develop programs to obtain the data for him. This overly centralized approach attempted to support the daily operation routine of the organization, provide the control for managerial support and provide executive decision-making capabilities, all with the same programs, and generally out of the same reports. The result was that executive officers of the corporation were looking at reports that were much too detailed, complex, and voluminous for their needs.

What next emerged from these conflicting needs and requirements was a series of small systems supporting the various functional areas. Layered over these functional divisions were other systems to provide for the needs of the various levels of management. With even a mere three functions and

three managerial perspectives, the result would be nine sets of system requirements. As the number of functional areas or management levels grew, the number of systems requirements started to explode.

B. CENTRALIZED OR DECENTRALIZED DESIGN

Fortunately, an alternative approach has started to emerge as the technology continues to mature [Ref. 16: p. 303]. This alternative uses transaction systems, which provide the details needed to support operational needs, recording the transaction data at the lowest levels. Layered above these systems, reusing the same data and investment of resources but creating separate summary and exception reports, is the Management Information System. The granularity of detail in the system can be scaled to fit the level of management and perspective required. Above this level special Decision Support Systems for the executive can be built. These combine further refinement of the information into summaries and include data external to the system or organization as well as powerful analysis tools to support policy decisions.

A multitude of conflicting demands between the functional elements of organization still exist, however. The original solution, based on technical limitations and political expediency, was to allow each function to be independent. This avoided the political problem of control of information and the power that the control conferred on the owner but it

wasted resources in collecting, storing, and retrieving the same data repeatedly for different functions. In time management's frustration at not being able to obtain a total picture of the organization's information gradually overcame the aversion to resolving the political issues of control. Simultaneously, the technology to deal with the larger volumes of data in a corporate system was developed, and large corporate data bases became the favored solution.

However, there was a price to pay for this solution: functional managers lost control of their operations; a new power structure, centered around data processing, emerged; and critical nuances of data were lost. The savings resulting from reduced duplication of effort were quickly lost as special exception systems were developed to fill the gaps in the corporation's system. Common sense suggested that the pendulum had swung too far, from the anarchy of each function's having its own system, to the dictatorship of one system. Recently a more reasoned, balanced solution has begun to develop.

A balance between the two extremes suggests a form of federation. The design of such a system is built around the following concepts:

1. Sharing data where it is appropriate to do so.
2. Using standard definitiions wherever practical.
3. Avoid all unnecessary duplication by sharing data in a modern database system.

4. Allowing special data for the various special needs of the individual functions.

5. Returning much of the operational control to the functional manager.

6. Employing an Information Systems Manager to protect the common interests of the organization (the federation).

7. Allowing reports to be developed and provided to each according to his needs.

8. Making each user responsible to the others for his share of the total operation.

Figure 2 portrays such a system [Ref. 16]. This provides the responsive support an organization needs and returns the data processing organization to the role of support to the organization. It works in much the way that the states of the Union relate to each other for those things that are common and go their own way for those things that are unique to each. This allows each element of the organization to have the special additional requirements that meet its needs while it provides for the sharing of common information for making decisions that affect more than one component of the organization. While the management of this type of structure is much more difficult, it allows all parts of the organization to have the data they need [Ref. 8]. Centralization versus decentralization becomes a mute issue and the control and location of the equipment can be placed where it is most responsive to the needs of the user. The staff required to support the hardware and the software can be either centralized or decentralized according to the needs of the organization

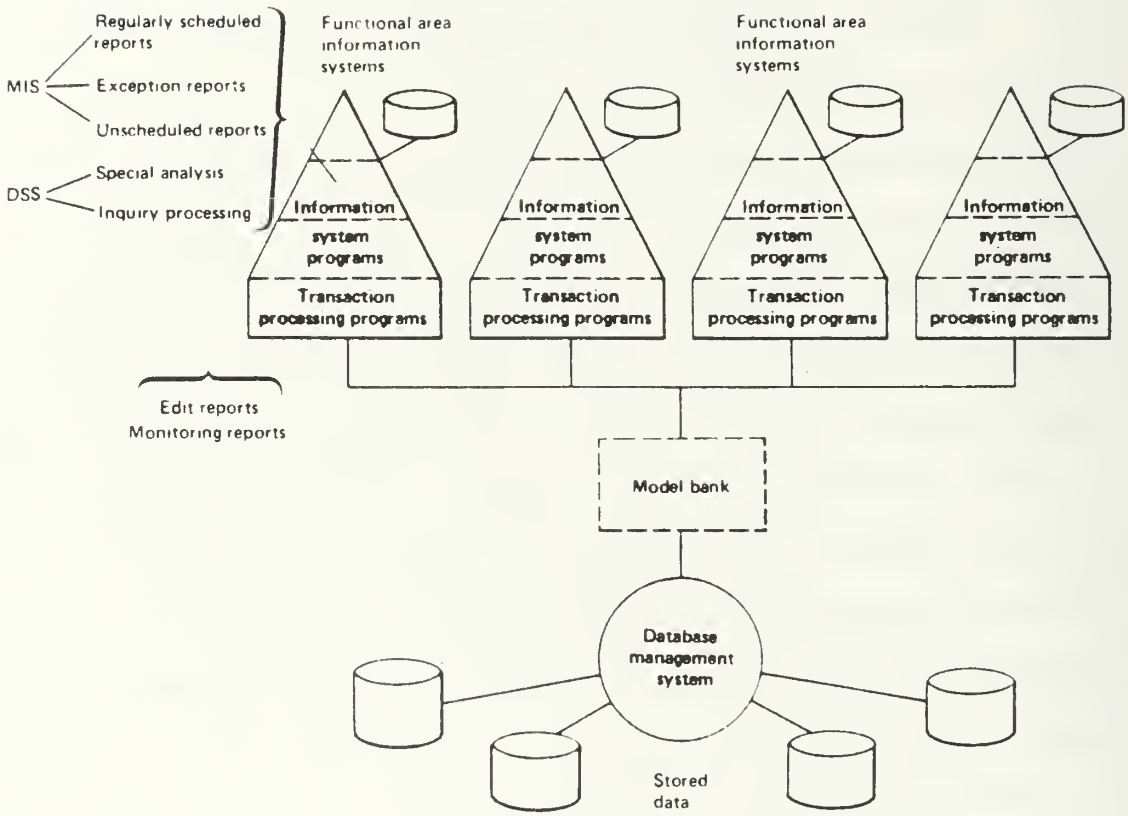

Figure 2. Federation of Information Systems with DBMS

and of the users. It may have centralized management and have decentralized responsibilities. Or it may have decentralized management and decentralized responsibilities [Ref.18]. The main concern is to address the issues of how and when data is to be shared and what data is to be updated, when and by whom, in order to ensure the ability to exchange the data easily and readily when it is needed [Ref. 19].

New systems will most likely gradually develop in four parts: data, voice, text, and image [Ref. 20]. All can be handled electronically through the new office systems that are being developed. Air Force experience with office automation suggests that automating should proceed in stages [Ref. 21]. They recommend that the order of development be (1) office automation (word processing); (2) storing and transmitting telephone messages (electronic mail); (3) development of a large-scale integrated information system; and (4) the development of interoffice electronic communications. Most of the office automation equipment is available in commercial packages. Automating an office is primarily a matter of determining which commercial package or combination of packages best meets the needs of the organization's method of doing business.

C. THE SYSTEM DESIGN PROCESS

Information systems are large, complex, and prone to problems. Accordingly, particular procedures have been

developed to design them. System design begins with identifying a set of problems to which automation is the solution. This set of problems must then be converted by a team of analysts, users, and management personnel into a statement of needs. The statement of needs will be divided into those issues that can be addressed with hardware and those that require software programming effort.

The question of hardware becomes an issue of availabiity. If there is already surplus owned hardware available, then it needs to be reviewed for its ability to meet the needs. If owned equipment is not available then there are two basic alternatives; time sharing, which means renting time on a vendor's set of hardware and purchasing. This design is basically technical and can be easily left in the hands of the data processing organization.

Developing software, the programs necessary to support the needs, is generally an entirely different matter. While commercial packages are frequently available to meet some needs, these may need to be tailored to the organization. If there are no commercially available packages that meet the needs of the organization, then a software development effort must be embarked on. This process is called software engineering, system development, or software development. The steps in this process are shown in figure 3 and discussed in the paragraphs below.

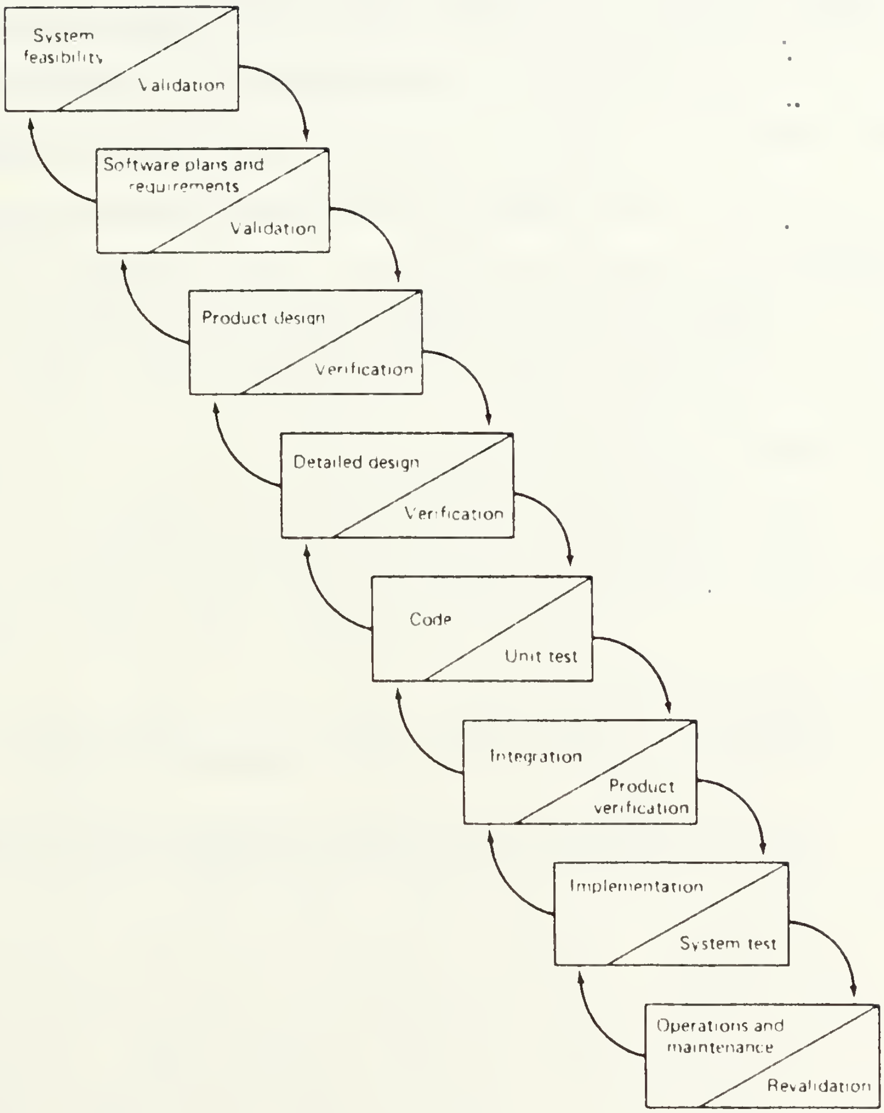

Figure 3. Diagram of Systems Development phases

These steps are given different names by other authors and are divided into more or less parts that are shown in figure 3 from Boehm's book, Software Engineering Economics. Generally accepted as the first step is requirements definition. The objective of this is to analyze the present system in terms of capabilities, shortcomings, and how it solves the problems of the business. A requirements document should describe in explicit detail the business problem to be solved and should identify any constraints to be considered, such as time or money. The product of this first phase is called a requirements definition report, which should discuss the following:

1. The business objectives
2. The functions the system is to perform
3. The inputs, outputs, and volume of data
4. What the data is
5. How this system must relate to other parts of the information system or other computer systems
6. A description of the organization and the data processing environment in which the system must operate.

Staffing in this phase of the system development is primarily data processing people supported by the user and any specialist that data processing may need to draw upon. There must be planned support and a plan for continuity of staff involvement during the development cycle.

The second phase of system development is called the conceptual design and is concerned with developing a functional

description of the system to be proposed. This should include a data processing description of the system and from this a preliminary design report. This report should provide:

1. A functional overview of how the new system will operate
2. What processes will be involved
3. What the system inputs are to be
4. How the data will be stored
5. What the outputs are
6. In what terms they will be provided
7. Whether this system will be some kind of a terminal query system or will be a paper report system.

During this phase considerations of where staffing will have to be adjusted will be reviewed. Quality assurance becomes a major factor at this stage; it must ensure that the design being proposed meets the original statement of the problem that this effort was supposed to solve.

A detailed design is the next stage of the development process. In this phase the conceptual design will be converted into detailed system specifications that will be used in the actual coding development and implementation of the new system. Planning documents must be reviewed and fleshed out in minute detail stating how the system will be developed, tested, and implemented. Planning must also include what kind of training will be provided to whom, when, and for what purpose. A very detailed plan must be developed showing how to convert from the current way of doing business

A plan for how existing data within the organization will be converted from its current storage mode to this new system must also be developed. Finally, programming specifications need to be developed to define each element of the system to ensure that nothing is overlooked.

The next phase is the actual development, the coding of the programs. Data processing skills will be a major requirement at this phase and will consume approximately 70% of the labor in this part of the development. The system specifications are now converted into actual program code and tested first as individual elements and then in larger and larger pieces until the toal system is tested. During this phase, documentation of all the efforts to data needs to be completed. Personnel training becomes a major factor. The deliverables at this stage are the operating system, complete documentation of the system, and a report of what has been done.

The next phase is the implementation of the system, first in a test mode and then in an operational mode in its production environment. The deliverables are the full system and a report of any problems that have been encountered.

Once the system has been implemented, declared operational, and accepted by the customer, it is time to do a post-implementation review. Go back to the original statement of the problem and ensure that the system that has been implemented meets the original set of requirements. If there are

shortfalls there need to be plans to rectify them. The system also needs to be evaluated again several months after it has been declared operational to see how well it is actually operating and how well it meets the actual users needs. This should be done by a separate organization and is frequently done by an internal review or internal audit component of the organization.

D. MANAGEMENT'S ROLE

This development process appears to be a continuous one from the point of view of the ADP staff and the development team, but for management it is a series of steps that are punctuated at intervals by formal reviews. At these reviews management has the right and responsibility to stop the progress of the development, to cancel the development, or to approve further development. These reviews should be carefully executed at each stage. Errors caught early in the definition phase are much less expensive than errors caught later on. Errors caught and corrected during the definition phase on the average will cost 1% of the cost of correcting the same error at the implementation stage of the development [Ref. 22: p. 33]. At each of these reviews, management must ask itself the following questions:

1. Does the design at this stage address all facets of the requirement specification?
2. Is each element of the proposed system traceable to one of the orginal requirements?

3. Will the implementation of the design require high risk or is this design achievable without technological breakthroughs?

4. Is the design a practical solution to the problem or is it too grandiose?

5. Is the system, as it has been proposed, designed, and ultimately developed, easily maintainable?

6. Does the design exhibit characteristics of quality?

7. Have the interfaces between this system and other systems been adequately defined and are solutions for the exchange of data well thought out?

8. Is there technical clarity in the design: is it expressed in a manner that can be easily understood?

9. Have all the alternatives been considered?

10. Are there limitations and are these limitations realistic and consistent with the requirements?

11. Is the software design testable and consistent with the elements of the rest of the system?

12. Is the documentation complete and easy to understand for a non-data-processing person?

There are a number of other less formal reviews that will be carried out within the development team; these are frequently referred to as informational reviews or structured walk-throughs. A complete record is necessary at each management review. In addition to the new system design documentation, an updated risk assessment and cost benefit should be prepared. It must be remembered that the objective of the review is to assure that the design and development are correct. These are not problem-solving sessions, but

they are reviews of what has been developed. Management must avoid getting sidetracked into trying to develop solutions to problems that the reviews uncover. Further, there should be a limit to the number of participants in these management reviews, and all participants in the reviews should be knowledgeable of the requirements of the system. Prior to each of these reviews, there should be several working-level preliminary reviews with the different parts of the organization that are involved in the system. The results of these preliminary reviews should be reported at the formal review. Mass meetings are not productive and will not contribute to the successful design and development of a system.

The user's role in the review process is primarily clarification: to provide clarification wherever there is confusion in the original documents (this clarification should also be documented) and to provide expertise as to how and why things should, could, or need to be done. The user needs to understand clearly and easily what the design is. Everything in the process needs to be committed to writing so that in the future it will be easier to understand why things were decided the way they were.

A further responsibility of the user is to discover errors in the design. Each and every step must be reviewed, using appropriate levels of people at each stage of the way.

If the issue is desk procedure design, for example, then the supervisor or representative of the people using the desks, should be involved, not top management. If the issue involves policy, on the other hand, then it is top management that should be involved, and not workers.

Management has a special role to review what has been done to ensure that everything is done and that only the needed resources are provided. People should not be committed to an effort merely to get them out of the way. People should be committed to the project in the amount required by the manager of the project and only in that amount.

Correcting errors early in the process will save money. Errors that are not found until late in the proces will either cost more money to correct or must be included in modifications of the system after it is declared operational. Which approach to take is a trade-off decision that must be made by the project manager, depending upon whether the error impacts the ability of the system to perform the role it was designed to perform or whether it is merely something nice to have.

E. SUMMARY

1. Exceptions to the normal must be considered in the system design.

2. The concept of a federated system allows the organization to have one system while the elements of the organization have their own systems.

3. The system development process is necessarily long and involved, to ensure that the new system will meet the needs of the organization.

4. Design errors detected early are cheaper and easier to correct.

5. Management has a responsibility to review the progress of a project and to stop, mondify the direction or approve at each step of the development.

6. User personnel must stay involved throughout the effort.

7. The staffing level should be only sufficient to meet the project managers' needs.

V. THE OFFICE ENVIRONMENT

A. INTRODUCTION

In the second chapter we were concerned with whether the office was functioning properly. The third chapter was devoted to general data processing issues. The previous chapter reviewed the ADP development process. This chapter focuses on the physical environment of the office.

The issues to be discussed are pertinent to non-automated offices as well. Whether the manager is concerned with improving productity or just concerned with the health of employees, the issues of office design, furniture design, and equipment design are still all relevant. The term ergonomics, a buzz word today, was coined early 1940s by Oxford University and is defined as the science seeking to adapt work or working conditions to the worker. It combines engineering, psychology, and physiology. Its goal is to match the capabilities of the human operator with the equipment in the environment of the work place. When designing, planning, and implementing changes in the office, we should consider ways in which humans, technology, and the environment can interact to maximize the effectiveness of all three. In the past, the only change made when automating an office was to place a terminal on an employee's desk. This approach would be satisfactory if terminals were

easy to use and designed for human's to begin with. But most terminals don't even fit on the typing stand attached to the average desk.

B. LIGHTING, SOUND, AND OTHER CONSIDERATIONS

Lighting is a critical factor. Titus Macius Saltus, a Roman philosopher in the days of the Roman Empire, wrote, "Sitting hurts your loins and staring hurts your eyes." In the 2,000 years since Titus we have not managed to progress very far in solving either of these problems.

There are three basic sources of light: (1) natural light, which comes through the windows of the offices; (2) the fluorescent lights that are so common in the office ceilings, which will augment the natural light, and (3) the incandescent light of the common light bulb. This incandescent light is most beneficial around computer terminals. In the area around these machines, lighting should be held to a minimum, on the order of 300 to 500 lux or 30 to 50 foot-candles. In a normal working environment, it should be in the neighborhood of 500 to 700 lux, approximately 50 to 75 foot-candles [Ref. 23]. Most offices in the United States are illuminated at a higher level.

Task lighting is a term that has been used to describe the amount of light needed in a particular location to perform a particular task. Task lighting often consists of a special light. It maybe an overhead spot light that can

be used for reading work or other work that requires a lot of visual clarity.

In the realm of lighting there are a number of basic rules to remember. Windows need to be dealt with in some manner to allow controlling the amount of light filtered through them. This can be done with drapes, shades, or reflective film over the blinds. In offices with windows, terminals should always be placed at right angles to the window light if possible. This will minimize glare when the employee's back is toward the window and when the employee is looking at a bright window and trying to see a duller terminal screen. Whenever possible, the ambient light in a work area should be the full spectrum light that comes through the window [Ref. 24]. It has been shown in a number of studies that this natural, full spectrum light reduces fatigue. In areas where video terminals are present we should minimize the amount of fluorescent lighting. If there is fluorescent lighting to provide ambient light in the office, then the light in the individual worker's area should be provided by incandescent bulbs. This is because fluorescent lighting is cyclical: it "flickers." Although fluorescent lights flicker at a rapid enough rate not to be consciously visible to the eye, the flicker is still perceived by the optic nerves. The screen in the computer terminal flickers in the same way. If enough additional

sources of flickering light are added, the optic nerve becomes overstressed and tires quite rapidly.

Glare is another problem with light. It reduces the speed with which employees are able to read, and it causes eye fatigue. Glare is nothing more than light reflecting off a bright surface and coming back at an unusual angle. Glare from overhead fixtures is probably the easiest to control. It can be controlled by a device called a parawedge screen, 1/2 inch-wide egg crating, inserted in the fluorescent fixture between the tubes and fixture's screen. Parawedge screens prevent light from being dispersed at varying angles throughout the room and thus reduce the amount of reflected light that the eye has to deal with. An even better way of eliminating glare is by optical engineering to provide indirect lighting. However, an expert needs to design the indirect lighting, and indirect lighting reduces flexibility in arranging the office.

Wall surfaces in the office should have a non-reflective finish. A muted color of paint reduces reflection, or wall paper of the matte type can be used. Darker colors should be used in the individual work areas directly behind the terminal screen.

Control of sound is easily taken care of. The worst offender in the automated office is the printer. Most printers operate in excess of 70 dB, and sound levels above 70 dB have been shown to cause physical reactions. High

frequency sound causes irritability and raises temperatures [Ref. 25: p. 399]. Before employing equipment of this type in the office it should be carefully tested to be sure it is below 70 dB or that sound control can and is installed to reduce the noise below 70 dB.

Frequently computer terminals have fans and other components attached to them that operate at very high frequencies. These can be distracting and cause irritability. The best way to control sound in the office is acoustical ceiling panels. Current government standards of 85 dB for long periods of time or up to 100 dB over shorter periods of time far exceed what human factors studies have shown to be a safe level for office workers.

In any office, air circulation, ventilation, humidity control, and often refrigeration are necessities. Too cold? The employees do not function; they concentrate instead on trying to keep warm. Too hot? Fatigue sets in very rapidly. The addition of electronic devices to the office creates additional sources of heat that must be taken into account in the design of the office or in installing the equipment. A rule of thumb is that each terminal will add an amount of heat equivalent to one additional person in the office.

Each individual work space should be provided with its own source of air if at all possible. Many of the modern modular furniture designs include air flow. Caution should

be exercised to be sure that this air flow is not directed at employees' faces, especially those who wear contact lenses.

In the office, space is at a premium, each individual should have a feeling of individual space that is their own. Psychologists have determined that this is very beneficial to maintaining good worker moral and harmonious working relationships among employees. Standards for clerical workers vary depending on the amount of equipment and storage space required, but an absolute minimum is 80 square feet. Supervisors and low-level managers require on the order of 200 square feet, and managers having large meetings require even more.

In order for a space to be considered to be an individual's own, it should have three walls to differentiate it from common space or other employees' space, and there should be a right for the employee to add a personal touch. Family pictures, a plant, and other things of this nature allow the employee to feel that it is his or hers. Employees should also be able to control part of their own environment: they should be able to turn lights on and off in their work space and control, to the extent practicable, the air flow. They should also have a voice in the wall coloring.

C. EQUIPMENT DESIGN

Position of equipment becomes critical to the employee in using computer terminals. The screen and any related

paper work should be at relatively the same eye level to avoid excess eye movement which can cause refocusing, loss of concentration and loss of productivity. The work surface, the screen and the paper work should be approximately 18 inches from the eyes and should be located so that the top of the screen is 10 degrees below eye level and the bottom of the screen is approximately 30 degrees below eye level. This is because the head needs to be in a normal position between veritcal and 15 degrees forward. Tilting further forward or backward creates stress and fast fatigue.

The terminal screen should be adjustable in three planes: left to right, up and down, and foward and backward. The angle of the screen should be adjustable. Character size should be at least 3 millimeters; smaller than this is too difficult to read. Most screens use a dot matrix, that is, a cluster of dots to form the individual letters. Most of these clusters will be from 3 dots wide and 5 dots down to 7-9 dots wide and 9-11 dots down. The preferred number of dots in this 3mm x 3mm block should be either 5x7 or 7x9; any less than this will make the letters too indistinct to be easily read [Ref. 26].

Positioning equipment for workers with bifocals presents a special problem. Their glasses literally are upside down for working with the terminal. They are used to reading through the very bottom part of the lense with their

eyes looking down at a rather severe angle. In order for them to look through the reading part of the bifocal lens, the head must be tipped back at a very unusual angle, which quickly creates strain. A workable solution is a special pair of glasses with the position of the two parts of the lens reversed.

A test was conducted on modern office furniture by Business Week for its editorial and writing staffs [Ref. 26]. Approximately two years ago, the magazine converted to a word processing system for preparing text. At that time, after being advised as to the pros and cons of this new equipment, each employee was provided the option of taking new-style office furniture or old-style furniture. After a short period of time, a large percentage of those using the old-style furniture with word processing equipment were found to have excess stress and fatigue and were complaining of physical disorders.

Furniture needs to be designed to support modern equipment and to facilitate the employees using the equipment. It needs to be adjustable to fit approximately 90% to 95% of the work force. Only limited studies of the general public's physiology have been made, so most designs must rely on the data collected by the military. These have been recorded in MIL-STD-41472B(21), which shows that 95% of the male work force is less than 74 inches tall and 95% of the female work force is taller than 60 inches tall. Therefore,

furniture needs to be designed to fit a range of employees from the 60-inch-tall to 74-inch tall individuals. In weight, the range is from slightly under 100 pounds to close to 300 poounds. It's easy to see that there needs to be a very wide degree of adjustability and flexibility in furniture.

The chair seat should be from 15 to 18 inches off the floor but needs to be adjustable. The back rest needs to be able to tilt from 10 to 20 degrees back from vertical [Ref. 40; p. 398]. The front edge of the seat should be rounded and have some give to it. If it is impossible to provide the employee with a low-enough chair, so that the feet can rest comfortably on the floor, then a foot rest should be provided.

The keyboard should be detachable from the computer screen. The work surface that the screen and keyboard sit on needs to be adjustable. the keyboard should be thin so that the wrist can rest on the desk top or an arm rest provided for that purpose. The keyboard needs to slope at approximately 16 degrees and be low enough so that the forearm is approximately horizontal. The angle of the wrist should be less than 10 degrees from horizontal. Frequently it will be necessary to have a separate work surface for the keyboard to rest on and a normal work surface for the terminal and for writing to be done on.

Some people like to hear a sound associated with their key strokes. Others find this annoying. Therefore this

should be an option provided with the terminal, preferably an option that does not have to be turned on and off by the vendor repairman. It should also be noted that most people using computer terminals prefer having a tactile signal associated with strokes of the keyboard.

The arrangement of the keyboard has received a lot of attention of late. However, there are no answers in this area. The standard typewriter keyboard that most people are familiar with is called a "QWERTY," after the letters on the rows of keys in the upper left-hand corner of the keyboard. This particular design was developed in the late 1800s to slow the finger movement of the typist so that early mechanical typewriters would not jam when gravity returned keys slowly back to their positions. Obviously, if it was designed to slow down the finger movements of the typist, it is not advantageous for maximum productivity. However, it is the only keyboard arrangement currently taught and the only one known by most people. Until some standard can be developed and employees trained to use it, it is the most practical keyboard arrangement to accept.

The color of the terminal screen has also received attention. Most vendors provide black and white. It can be argued that it looks like paper, and it is also the least expensive to manufacture. However, a number of studies, both in the United States and in Europe, tend to agree that the lower part of the light spectrum, the amber-yellow-green

regions, absorbe more of the energy being emitted in the cathode ray tube and are, therefore, the better colors to use. Some studies have shown significantly higher productivity using these colors over black and white, due to reduced eye strain. Productivity gains have been claimed to be on the order of 3 to 1 [Ref. 24].

Screens need to be cleaned frequently. There is an ion charge associated with the surface of the screen, and dust tends to collect there. Also the operator will leave finger prints on the screen from touching it. There should be no chrome on the terminal; it should have a dull finish [Ref. 27: p. 122].

Static needs to be controlled. There are sprays that can be sprayed on the screen to reduce the amount of static emitted from them. The equipment and the furniture should be grounded to reduce static build-up and humidity controls should be added if necessary.

The size of the equipment also is a factor. The terminal's "footprint" takes away part of the work space on the desk surface. When this is done, there is less space left for the employee to use in routine activities that still will be carried on. Therefore, additional desk space or a separate terminal stand may be needed.

D. HEALTH ISSUES

Much has been written about the health aspects of electronic equipment. The National Institute of Occupational Safety and Health has conducted a number of studies in this area. A copy of this report can be obtained from the U.S. Government Printing Office, Government Documentation Identification Number 017032003874. One of their recommendations is that after every hour of intense work at a terminal, or two hours of casual work, a 15-minute break should be taken. This work break needs to be away from the work station. In many offices, this is going to mean the creation of some sort of lounge or rest area where employees can get away from their terminals and relax, without disturbing other employees.

A number of studies have dealt with the stress that takes place in the automated environment, particularly as it relates to the office. One study conducted at the University of California at Berkeley suggests that employees are becoming so adapted to the way computers operate that when they get to the point where they depend upon them, they expect the world they live in to respond to them in the same way [Ref. 28]. Stress in this extreme form may exhibit itself in impatience to the point of emotional debility verging on exhaustion. To avoid this, the study suggested, employees need emotional decompression time at the end of

the day. Employees that experience prolonged use of computer terminals tend to exhibit a visual phenomen called the McCullough effect, which causes them to see dots of colors for some time after they stop using it. Employees may exhibit physical pain from the poor posture required to operate terminals if there is not proper office furniture provided.

A study done in Vienna showed that the clarity of focus for the average person's eyes does not return to normal for more than 16 minutes after 4 hours of work at a display screen. In fact, the Viennese government has proposed a limit of four hours work on one of these terminals per day, with a mandatory 15-minute break after two hours. The Austrian Federal Government has gone further and the British Postal Service has stipulated 100 minutes a day as a maximum time for an operator with no more than 50 minutes continuous work.

A two-year study completed in July 1983 by NIOSH found that most of the complaints about visual problems were the result of improperly maintained, poor-quality equipment, poor design of the work station, and poor lighting. In no case did they find a significant level of radiation. In fact, after taking extensive, detailed measurements of these devices they found that in those few cases in which they could get a recording on their instruments, it would

take thousands of times the amount of radiation emitted from the terminal to produce cataracts.

Wallach [Ref. 24] has done a number of studies on the effect of ions in conjunction with terminals in the office and in air traffic controller facilities with radar screens (which are also CRT screens) and has volunteered this information:

> One aspect of all directly viewed CRT-type VDTs but not plasma displays or optical projection systems have in common is a high positive charge on the exterior of the screen. This charge can be any where from 2000 to 8000 volts. Since it is backed up by very little current it is not readily apparent to us. As operators of these terminals we also have charges on our skin and these charges range from several hundred positive volts to 1000 negative volts. A conservative figure is said to be -400-volt charge. A typical electronical field between the CRT and the operator is thus the difference between a positive charge of 2000 volts and a negative charge of 400 volts or 2400 volts over a distance of 18 inches. This divides into approximately 150 volts per inch. Natural voltage gradients outside in fresh air rarely exceed /-3 volts per inch. One-fiftieth (1/50) that claimed in the experience of the operator in front of the screen.

What does this mean? The claim is that the positive screen is attracting all negative ions out of the air and is repelling positive ions toward and beyond the operator. Too many positive ions or the absence of negative ions in the environment are claimed to slow down metabolism and cause disturbance to the cardiovascular, digestive and the nervous systems. In addition, the headaches, nausea, and allergy symptoms that some people have alleged to be associated with too much exposure to the screen can be replicated in

the laboratory by increasing the positive ions and decreasing negative ions or by removing both. British studies have asserted that the performance could be enhanced by as much as 28% by generating supplemental negative ions in the atmosphere. Ion imbalances are allegedly associated in modern offices with the increased use of air conditioning, heating elements, and electro-static filtration systems. There is hardly a building left that allows windows to be open to let fresh air in. Although no one knows the impact of automation on employee's health, it should be kept in mind that there is some laboratory substantiation of the claim that terminal screens cause the symptoms mentioned.

In California a bill is currently pending that would reassign pregnant terminal operators to other jobs in the office. there have been a number of claims pro and con on the fetal harm from CRT screens. The U.S. Government has studied it, the Communicable Disease Center in Atlanta has studied it, NIOSH, has studied it, but as yet the only thing that they can attribute the birth defects problem to is statistical clustering: that is, in sampling small samples it is not unusual to find a grouping of events, even if the events are not evenly distributed through larger samples. An employee who is pregnant should have the right to remove herself from terminals, at least until more is determined about the possible danger to their children. The wise manager

would probably do well to have jobs available for pregnant employees so they can escape exposure to the computer terminals at least part of the day.

When we redesign offices, we should also keep in mind the Government policy to employ the handicapped. Experts need to be consulted in this area, but a couple of things should be kept in mind at least. The length of an occupied wheelchair with the employee's feet resting on a foot rest, is about 52 inches. The width needed to be able to move a wheelchair is a minimum of 32 inches. In constructing sloping ramps to accommodate wheelchairs, the slope should be no more than 1 inch up for every 12 inches in distance. For the handicapped in sight or hearing, special equipment is needed, and a manager needs to work closely with the employee. There are no general rules that can be applied here.

E. SUMMARY

1. Ergonomics is the science of matching human needs to office equipment and environment, to improve productiv productivity

2. Lighting must be controlled in the modern office to fit the needs of the user and minimize fatigue.

3. Excessive noise, above 70 decibels, is physically harmful and reduces productivity.

4. Furniture should fit the individual and the job.

5. Letters on terminal screens should have a minimum of 5x7 dots and characters should be at least 3mm in size.

6. While the answers to all health questions are not clear, attention needs to be paid to this issue.

VI. INDIVIDUAL IMPACT

A. INTRODUCTION

As with most technology the computer will have unforeseen impacts on people, particularly its users [Ref. 29]. The next two chapters are concerned with showing some of the transitions that will have to take place in ways of doing business and ways to minimize their impact. These changes are taking place so much faster that it is difficult for the manager to deal with. In the case of the typewriter, it took over 25 years just to define a standard keyboard. The standard typewriter has been in the office for over 100 years, and now in less than 20 years, it will be replaced.

The impact of that change is just beginning to hit the office. The last major change that impacted society was the industrial revolution, and that took 100 years of turmoil, revolution, counter-revolution, and social upheaval before it began to stabilize [Ref. 30]. John Diebold made the statement that "One has only to look at the impact of the industrial revolution to see that the computer age will and has had a profound impact on mankind." [Ref. 31]. When was the last time you remember noticing the statement "Do not fold, spindle, or mutilate?" When computerized bills first came out they were a great source of irritation to many people, but they are now so common and accepted that most people don't even notice the little statement on the card.

B. COMPUTER OPERATIONS

Workers in automated offices are still drowning in a sea of paper, although now it is computer printout [Ref. 32]. The fact remains that for each computer operation there are two human actions required. One is to start the process; this may range from just starting the machine to a very complex data-gathering, analysis, and input process. The second action required is to do something with the computer's product.

Computers are often though of as displaying what is casually thought of as intelligence. Actually what they are doing is high-speed computations based on pre-defined sets of logic. It is the invisibility of the computer's work, which fascinates some and repulses others, that gives the appearance of intelligence.

In fact, computers do not do anything by themselves. In a process as common as using a credit card at Sears using their point of sales system, someone had to price the product, feed that information into the computer, get little optical scan stickers, append tags to the merchandise, read the sticker with an optical scanner, and read the credit card. The computer then processes this information to charge the customer's account, and adjust the inventory on hand.

A bill then has to be mailed to the customer, and the customer's must respond to it. Additionally merchandise or replacement merchandise has to be ordered. Employees must be trained to perform these operations or the "computer" system won't work. The vocabulary used to describe this process is unfamiliar to most people; this makes it all the more difficult to learn the process. The manager does not know how to explain the job and the system designer does not know how to explain it either [Ref. 32].

The communication between the human and the machine is typically less than a satisfactory experience. "End users", in particular (as distinguished from programmers) need more flexibility in the dialogue, such as the option to choose step-by-step prompting or a succinct, short-cut method, depending on their knowledge, skill, and experience. Much of the problem that exists in dealing with these machines is they lack any kind of sensory perception. Humans communicate with their eyes, ears, bodies, and emotions; machines can only use data, whether keypunch cards or keystrokes on a terminal. The ways that humans are used to communicating cannot be dealt with by a computer. The human as part of a larger system has two processes working at any one time and a wide array of sensors supporting him; he is only limited in his responses by the system's limits [Ref. 33: p. 68].

Workers are individuals with various needs that must be met. Maslow described a theory of levels of needs in people, and Thompson [Ref. 34] has suggested that the organization personality of an individual is a reflection of his true personality and that the latter will drive the former. Therefore, managers must expect job satisfaction to be different for different employees and therefore not expect one solution to make all the work force happy. Human operators can handle a high degree of complexity if it is presented carefully so as to fit the existing conceptual framework of the individual. Most errors that result from human processing are either random errors, which can be eliminated by filters, or systematic errors, which indicate an inappropriate system design or some kind of a personal abnormality that can also be dealt with.

The Taylor school of thought that dominated industrial psychology until the 1930s said that standards could be set and work divided into simpler and simpler tasks. This does not seem to work in the computer environment. IBM in the 1930s developed an idea that they called job enlargement [Ref. 25]. Others have since adapted and modified this idea, and it has come to have the general name of job enrichment. This can mean giving different kinds of tasks to a person, so that he or she has a greater sense of job completion. An alternative is to assign a larger part of a single job,

a vertical expansion. This usually equates to greater responsibility. The employees must be involved in designing job enrichment, so that a fit is made to the individual's capabilities and needs.

Technology provides us with an opportunity for change, good or bad. Its impact must be controlled by the decisions of the manager and the designers of the automated systems. It can improve the quality of work or make the office a living hell. It depends on the design and the strategy employed. Most managers will say that they wan the user to be satisified, but they must understand the needs of the people and balance these needs against the needs of the office. Karl Albrecht (figure 4) has suggested that what the employee wants may not be what management thinks the employee wants; therefore it is incumbent upon the manager to be sure of what the employees need.

Job Factors	Perception of Supervisors	Reports of Workers
Good Wages	1	5
Job Security	2	4
Promotion and growth with company	3	7
Good working conditions	4	9
Interesting work	5	6
Management loyalty to workers	6	8
Tactful disciplining	7	10
Full appreciation of work done	8	1
Sympathetic understanding of personal problems	9	3
Feeling "in" on things	10	2

Figure 4 RANKING OF EMPLOYEE DESIRES FROM THE JOB

C. SYSTEM DESIGN

There are five ways that we can approach systems design.

1. We can approach it as an organizational communication problem, believing that the organization is a communication network and that the quality of communication reflects the performance and effectiveness of the organization. This suggests that the organization exists to process communications and that purchase orders, inventory forms, and product data are merely communication devices.

2. We can approach the system design as a series of functions to accomplish the mission of the organization. This approach says that offices do not exist to communicate; they use information. Offices exist to fill the organization's needs, and therefore any system must have as its basic goal a design to improve or support that activity.

3. A newer concept is that information is a resource that must be managed and that the purpose of the system is to collect and store data. Similarly, the system can be viewed as a kind of decision support system whose purpose is to aid the decision maker in meeting his responsibilities.

4. Another view combines the first three. The organization exists to process communications. The organization's functions are what the communications are all about. Collection and storage of data are done to support these functions.

5. Finally, there is the view that all these are important but that in developing systems we must optimize the effectiveness of the social and technical components of the whole system, including people, computers, and a communication system. This view emphasizes that there are two parts to every system: (1) tools, techniques, and methods to do the work and (2) a social system of people who do their work with these tools, techniques, and methods. The social system operates to join together the tools to coordinate them and enable the technical system to meet the demands of the environment. The computer system can enrich work or detract from the social system; therefore, in system design all these things must fit together.

According to this view, the "quality of work life" is what entices the worker to support the organization. Quality of work life includes the factors that motivate the workers and psychological and physiological needs of the workers. Paying attention to the quality of work life can reduce the potential damage to the organization that ill-planned automation can cause. It is the idea behind the vaunted Japanese management technique, which we actually taught the Japanese 40 years ago.

It should be kept in mind that, on the other side of the coin, the quality of work life can be manipulated to increase the supervisor's control. We can create drones out of the workers, especially workers in high-volume repetitive tasks like those in an insurance claims office. The physical atmosphere may be pleasant, but the pressure on the employee so great that it negates the positive things that were done for the employee. The result is a modern reversion to piece work. The office manager, however, has one advantage in designing, and implementing his system: automation has already been implemented in the industrial and manufacturing environments [Ref. 36].

D. INTRODUCING AUTOMATION

In bringing automation into an organization the first effort should be in an area where there is a 100% assurance of success. People are more willing to accept the successful

than the unsuccessful. Because most automation will be retro-fitted into an existing operation, morale problems can result even when there are no workers displaced.

Ideally, in introducing automation into an organization, it should be part of an expansion of capacity or development of a new capability. Some of the lessons learned in the manufacturing environment suggests that automation should first be used for the least desirable jobs. Whenever possible, the people affected should be involved in the planning, especially in any areas where there are critical interfaces. There must be a large, thorough training program before the installation. All the employees need to be trained, need to know what to expect and how to deal with it. A manager should try to create what Westinghouse calls a "sense of ownership" in the employees involved. A carefully designed, long-term forecast of requirements in terms of levels of jobs and a strong plan for any displacement needs to be developed very early in the cycle, made public, and approved.

It needs to be recognized that many of the skills in the new system will be completely new, and management needs to help the employee plan to move to a place where his skills can be employed or help the employee get the skills that will be required. Both formal and informal communication should be used throughout the planning, development, and implementation phases. If there is a union, it needs to be

involved. One of the best examples of the introduction of new technology is the plant in Fremont, California where Chevrolet Novas are being built using Japanese technology and American workers. For a year before the first cars were manufactured, employees were being trained, first in Japan and then in this country, so that they thoroughly understood what the system was all about, what the techniques were, and how to live and deal with this new way of building automobiles.

There is no straightforward measure of productivity in an office. Any measurement tools that exist in automation need to be used to provide feedback to the user, not for the manager to establish some kind of arbitrary performance standards. If management insists on using arbitrary standards, such as key strokes, employees will find ways to defeat them. Instead of using the tools to maximize the individual's efficiency, they will use the automation as a tool to protect themselves from management. For example, on a word processing machine, a tab used to create a column of data can be replaced with multiple space-bar strokes. It looks like a lot of key strokes instead of one key stroke.

Often employees exhibit self-doubt and loss of confidence over not being able to quickly learn to use automated machines or respond to them as fast as they can respond to the worker. Work becomes a mental exercise with none of the rests that

past physical activity provided; this seems to increase anxiety. Some of the solutions that have been suggested are:

1. Management must not lose sight of the fact that human beings are their most precious resource.

2. Frequent short breaks need to be scheduled and made mandatory.

3. There should be no quota system installed. Measurements of productivity should be fed back to the employee and not to the manager.

4. There should be a variety of work provided so that, whenever possible, operators do not spend a full work day at a terminal.

5. There should be decompression time at the end of the day.

6. Appropriate furniture should be provided.

7. Redesign of the work should be done to the maximum extent possible to provide job enrichment.

During the training and implementation phase of a new system, there will be a requirement for extra personnel, because people will work more slowly and produce less. The employee needs to participate in the planning of all this, and the manager needs to watch for little signs of trouble (such as upside down bifocals).

Probably the least prepared and able to deal with automation is management, itself. These people are well read, and are generally aware of the fact that the element of the workforce that has suffered the most in terms of loss of employment from automation has been the managerial ranks, especially at the lower level. Furthermore, these

supervisors must learn new skills. Instead of directing employees in performing routine functions that the manager was very familiar with, he must develop a new set of skills that help bring out the talent of the employee to perform the new job [Ref. 37].

Two years ago, a study suggested that there was little or no impact on the manager or the executive from personal computers. The study, conducted at United Technologies, pointed out that these managers did not have time to put data into these small computers, so they did not deal with them. Although the personal computers were fairly common with the work force at United Technologies, many of the executives sampled did not even know how to type. They were not required to have keyboard skills. The hope at the time was that 20% of the managers would regularly use the personal computers provided by the company and that 40% would use them occasionally. After a year of effort and strong encouragement from the chairman, it was found that the 20% level was overly optimistic.

Fifteen months later, another study conducted elsewhere suggested that there was growing reliance on the personal computer in the office that it was speeding up the flow of business for the individual manager, and that the computer gave the manager more time to do other jobs [Ref. 38]. Personal computers were primarily found in finance and planning departments, and the individuals using them often had

no prior knowledge of computers. Many of them were getting computers to have in their homes. Management seems to have changed in the last few years from an attitude of apathy to a strong attitude embracing this new technology.

Data processing departments are learning that the personal computer is a very useful device to take a lot of the "what if" analytical questions off the overloaded central computers, and managers are finding that it takes less effort to access information. Also the personal computer is a means of keeping sensitive information secure, such as the bonuses to be distributed over the next fiscal period. Special software to create electronic spread sheets has improved many "what if" exercises, simplified meetings, and helped prepare attendees. Many secretaries and assistants are tending to become information caretakers for their supervisor. Managers have noted a danger however; the tendency of the average person not to question data that is printed. Since all data is printed when these new small computers are used, no data is questioned.

E. TRAINING

Where does the training come from to support the employees? Vendors now provide very little or none in many cases [Ref. 39]. The answer is: the computer itself. Industry has long experience in using the computer as a tutor. They find it works well, is inexpensive, and in controlled

experiments has proven to be superior to the classroom. The training team for these new systems should be composed of supervisors, equipment specialists, and training professionals [Ref. 40]. The goal should be to learn how to get the machine to work for the operator, not what the machine can do.

Training should be provided in a series of levels, not all at one time. The training should result in the employee's feeling that he has enslaved the equipment to work for him, rather than the other way around. It should be remembered, that different people learn at different speeds and in different ways. Managers need to accept this as a simple fact of life and be prepared for different employees to reach different levels of proficiency at different rates of speed.

The implementation training should be designed to train all personnel. The time invested is well spent. All the employees need an overview of the total system, but only detailed training in their own area. There should be real practice, not just talk. Fear can only be alleviated by familiarity, and there needs to be an opportunity for the organization to practice before any new implementation.

One of the most misunderstood and misused phrases is "user friendly." Every vendor will try to say that what he is selling is user friendly. Stand [Ref. 41[has suggested that there are six criteria that can be used to define user friendly.

1. Can you begin using the program immediately, or do you need a manual? If a tutorial system is used, the tutorial system itself should be easy to learn.

2. If you must read a manual, is the documentation understandable, written in terms that the average employee can absorb.

3. Is there efficiency in the system? Are the more advanced features available for the experienced user in the form of short cuts that make it easier to accomplish tasks?

4. Is there some form of error trapping or can you easily make a mistake that hangs up the program? Can you accidentally make a choice that is virtually impossible to reverse? If you can do this, do you get an error message warning you, or can you fall into the trap unaware?

5. Is there onscreen help available? Are there choices as to what you want to ask help for and how you want to ask for it? Is it truly helpful? Can an inexperienced operator use the help routine actually to accomplish something or is it just a ritual?

6. Does the program automatically save things or does it warn you when you attempt to destroy some of your data? Do you find yourself with no safeguards and only by luck avoid destroying your data?

F. SUMMARY

1. New systems represent change to the people whose lives are affected, and this change is occurring even more frequently and profoundly with the introduction of newer technology.

2. Computers still require people to do part of the work. Humans can't be replaced; only their job duties change.

3. The design of new systems must take human needs and desires into consideration.

4. The design must fit the computer and employees together as complementary elements of a team designed to meet both the needs of the people and the goals of the organization.

5. When introducing automation, the manager must select as his first effort one of guaranteed success that involves the workers and is carefully planned.

6. Failure to pay attention to details of human needs will introduce unnecessary stress and anxiety, which will negatively impact the success of the system.

7. The great risk is with the management team.

8. Careful planning of training for all personnel is a must.

VII. SOCIOLOGICAL IMPACTS

A. INTRODUCTION

Any organization is a small community of individuals, which contains factions and elements that represent various points of view. It is divergence in these points of view that result in the turmoil normally associated with introducing computer systems.

Nesbit, among others, has documented a trend in the economy; the majority of workers are becoming more and more involved in processing information and less in production jobs [Ref. 42]. Statistics from the Bureau of Census show that the labor pool of new employees is shrinking and that we are going to have to find ways to do the same amount of work with less people.

The fear that most people express of computers can be diminished through knowledge [Ref. 43]. Apprehension over new technology is to be expected and can be seen in virtually every innovation that mankind has experienced. A partial list [Ref. 44] of the areas of life affected by automation includes job characteristics, satisfaction with work and the quality of working life, psychological reactions, physical health, organizational centralization, policies and communications. Automation may have an impact on society on at least two levels the individual and the organization.

Contrary to what many computer vendors have suggested, computer use does not cause work of a clerical nature to leave the professional's desk. In fact, it becomes easier for him to control it and to do it himself. Therefore, he does not need anyone else to do it for him. The indispensable jobs will be those that embody the unautomatable skills of judgement. The impact of office systems does not result from either the technology itself nor from the characteristics of the people in the organizations. The impact is instead a function of the way the system interacts with the organizational setting. Designing appropriate procedures and patterns of access to computers is hard work, but it pays off in benefits to the office system.

B. ISSUES

Privacy is an important social issue. As individuals, we have the right to privacy and the right to know what is known about us. This, in fact, has been made a legal right. Our definition of privacy is affected by the times we live in. It is not just a computer-related issue, but it is made more pronounced by the computer's ability to store, sort, and retrieve large amounts of data. Although a computer system may appear very innocuous, it can extract a tremendous amount of information about an individual [Ref. 45].

Another issue, employment, is really two issues in one: what kind of jobs we will have and whether we will have a job at all. In the history of modern man, there has been a tremendous amount of technological growth and growth in the labor force. The number of people unemployed has not grown out of proportion to the whole population. In the past there have been perturbations in the work force that greatly impacted individual human beings. Automation has improved the quality, accuracy, speed, and availability of information and has sometimes been used where conditions were unsafe or unpleasant for humans.

There has been a greater trend toward automation in industry than in the office in the last five years. We are beginning to see a split in the skills needed in our work force, machine "tenders" versus users and support teams. Many workers fear being displaced and replaced by machines. This fear has been around for centruies, and it is the responsibility of a manager to address it. Fear of automation seems to arise from the way the automation is implemented. By correct implementation, we can get job enlargement and greater inter-dependencies rather than divisions in the workforce. We can also improve the quality of working life and stop the trend toward specialization, isolation, and alienation that has permeated modern production methods.

The area of clerical work is undergoing a loss of middle jobs. The coordination jobs that clerical workers have

traditionally been promoted to have been removed, reducing opportunities for upward mobility. Thus, although in aggregate no major harm has come to society from automation, automation has adversely impacted individuals. Often automation, has been a harsh and traumatic experience for the individual. Unions have been able to mitigate the adverse affects of automation for clerical workers, but for the professional there is no union. Unions usually try to force management to relocate the employee elsewhere in the company. If this is not possible, and the work force must be reduced, the attrition that occurs naturally from retirement is used as must as possible to absorb the reduction. Of course, for a union, there is strength in numbers. As their numbers decrease, their strength deteriorates. Various compensation packages such as retention pay, lump-sum settlements, higher salaries, or forms of profit sharing are also used to soften the impact of automation. Early retirement may also be used to expedite the attrition rate.

Power is also an issue. Information is power, and whatever element of the organization gains control of the computer gains power. In some companies this is stopped by greater sharing of the system. Although one of the laws of computer science has been that bigger machines were cheaper (Grosch's Law), the most recent changes in computer technology seem to defy Grosch's Law; and the use of smaller

machines is being accelerated by the fact that centralization of computer systems caused too much concentration of power in the past.

Bjorn Anderson [Ref. 46: p, 106] divides the impact of automation into two types, direct and indirect. The direct impact is the way that man has changed in relation to the organization. The indirect impact is the change in the relations between one man and another.

Originally it was predicted that managers would be the ones replaced by machines. Instead it was the clerical level that bore most of the impact. Articles in Business Week, Harvard Business Review, and others have suggested that this trend, under the pressure of a weak economy during the late 1970s and early 1980s, has begun to change and that it is now the managerial ranks that are suffering the impact [Ref. 47]. Historically, technology has often been held at bay by the worker. This no longer seems to be possible because of the weakness of the economy. Automating the office has generally resulted in increased specialization and increased skills and elimination of many support jobs. We may see some lower jobs eliminated and others grow or be reshaped. The impact on managers has been to decrease their ranks in the lower levels. Most often, the trend has been toward centralization, more power to upper management and less flexibility and discretion for the individual employee.

Data processing has also often served to create new power centers. There has been a greater temptation on the part of management to engage in "Big Brother", 1984-style control of the employee. The employee has generally been able to outwit this trend, partly because unions are very concerned about this concentration of power.

Another social issue is job satisfaction. There is less physical pleasure in many jobs in an automated office because of ergonomic problems. Although there are fewer hazards, there is also less comfort in the work place. Psychologically, employees have tended to adapt to the new only because it was new (and therefore supposedly better) or because no alternative was seen. Existing job alienation can continue or be mitigated, depending on whether these issues are taken into consideration when designing new systems.

The computer's capability to invade personal lives and work performances is reportedly a fear that exists in at least half of the population [Ref. 48: P. 225]. A number of laws have been passed to restrict access to data that deals with individuals and to have the data that deals with individuals made accessible to those individuals.

The computer is a result of an evolutionary process that began with the stone age man and the process of learning to count. The computers can do a lot of positive things, it can store and collect facts and automatically make simple decisions. Its primary role has been to perform repetitious

calculations, to take the drudgery out of repetitive data processing. Since the computer can do repetitive collecting and storing, it should result in a reduction of that type of job. The truth is that this has not happened. Management, in its thirst for information, has caused the jobs to be modified and redefined, employees retained and retrained, to extract more information from the data collected.

It seems a common opinion that, if data is printed or is from a computer, the information is always correct. This is not true. Data is only as accurate as the people providing it. In fact, it is largely the inaccuracy of information that has led to such things as the Privacy Act to protect us from improper use of information and to require correction of errors.

C. SOLUTIONS

John D. Rockefeller may have said it best when he said "I will pay more for the ability to deal with people than any other ability under the sun." A manager must remember that organizations are social systems whose problems are thus amenable to many basic solutions developed by behavioral science over the years. Maslow's hierarchy of needs specifically shows us that people who are gainfully employed are going to feel that social needs are a significant factor. The astute manager will use the informal social order that naturally tends to develop, to make a conversion to computer

systems smoother. A 1948 study done by Vengall suggested that workers want appreciation, to feel that they are a part of things, that management understands their problems, and, last, job security and good wages. The Hawthorne Studies point out the affect of management's paying attention to employees. The MacGregor Studies show that people have the potential to act in a mature manner.

Work can be fun if the goals of the organization and its employees are similar. Humanistic democratic values in an organization tend to lead to improved group interaction and a more efficient organization. Agryis points out that practices of control create a passive employee and a dependent subordinate who is encouraged to act immaturely. Most formal organizations discourage employees from taking the initiative and from modifying the design of the work place. In the design of the organization, the work place often comes first and then people become programmed parts of it. When management takes these attitudes, there may be adverse reactions from the employees. Hertzburg discusses a number of environmental factors, which he calls hygiene factors. Positive factors in the work environment include opportunities for achievement and recognition. The chance to have a challenging job and a sense of responsibility with an opportunity for growth and development are necessary for job satisfaction.

If a manager knows what employees want, he can provide for the needs of the employee and move toward the organization's

goal. People are one of the basic assets of any organization and must be treated as such. A manager needs to realize that the process of changing the office with automation can be either a positive or negative experience for the employee. The result will be either a positive or negative reaction. Pygmalion saw that the difference in people was how they were treated. If a manager expects good things from his employee, the results will be good.

Management of change can range from dictatorial to group leading. There is no best way. It depends on the organization, the climate, and the people. It is incumbent upon a manager to be able to sense these and choose the alternative that fits the situation. He must be able to develop a process that unfreezes the attitudes of the employees so that they no longer believe that the old way is the only way. Through training, a manager can create an atmosphere amenable to change in the direction that fits the goals of the organization and rewards the employee. Finally, through the use of rewards, he can "refreeze" the employees' attitudes to do things the new way [Ref. 48: P. 8].

In 1983 a study of advanced office systems and automation was done by the Rand Corporation. This study found six outcomes relevant to the implementation of new systems [Ref. 49]:

1. White-collar offices can be classified into 4 types: managerial and administrative, data oriented, text oriented, and supporting organizations.

2. White-collar work forms systematic clusters of information handling activities.

3. A large percentage of employees including senior managers and professionals are using computers in their work, and most non-users expect to be in the future. [This expectancey is one of the advantages that the manager responsible for creating an automation system has in his favor].

4. There are four concerns that users of computer systems appear to foster. Is it functional? What kind of performance does the equipment provide? What are its interactive features? What is the office environment?

5. Among these four aspects of computer systems, satisfaction with functionality is the best predictor of use of the system. Therefore, the manager must ensure that the functionality provided in the system meets the needs and desires of the employee and the goals of the organization.

6. The most important organizational influences on the use and satisfaction of information technology are the variety in work and the organization's approach to technological change. The quality of working life must be a major consideration in the design of any automated system. The organization's attitude towards the impact that the system is having on the employee, both physiologically and psychologically is of paramount importance.

D. SUMMARY

1. Fear of computers can have an adverse physical impact on people's health.

2. Social issues related to computers include privacy, employment, power, and position.

3. Computers affect the entire office organization from the president to the mailroom clerk.

4. The manager should use organizational skills already learned to care about the human beings in the office.

VIII. INTEGRATING THE EFFORT

A. USERS AND DESIGNERS

While doing those activities that are necessary to the organization, the manager must also be sure that the dialogue with the design development team and the efforts of the designers and the developers are monitored to ensure that the design and the development effort are meeting the defined needs of the user. A manager must also concern himself with whether or not the design development team is on schedule or behind schedule. To do all this requires a "bridge" that can be provided by having several of his best people serve on the design team.

In the modern, complex type of system under examination, only the user really knows what the requirements are; therefore, the user must play a prominent role in defining the system. He must be careful to limit himself to defining needs, while leaving it in the hands of the professional data processing team to decide how these needs are met. The methodology called systems analysis or software engineering is designed to ensure that the system meets the needs of the user. This very process, however, contains within it the seeds of political dissension, as the goals of different users conflict or (more importantly) the goals of the user and the design team are different.

Designing an automated system requires an awareness that a political process is taking place in which the parties involved stand to gain or lose power depending upon what their own personal positions in the previous system were and how their position will be changed in the new organization. In particular, organization theorists [Ref. 50] have become aware of the need to ensure that this political activity does not replace a rational approach in designing the system to enhance the performance of the organization.

Users should participate in system design in order to control important issues and to resolve differences of opinion between themselves and the design team. One way to help achieve this is to involve top management in the formation of a steering committee. A second approach is by having the users participate in the requirements analysis stages of determining what the needs are, when the user may express his involvement through the use of prototypes developed to test what changes can and should be implemented before the main design is completed. These less formal approaches will complement the structured approaches that have been discussed earlier. Although there are more parties than simply systems developers and users, these are the principal players. If an awareness is maintained of the political interaction between these two the manager is more likely to ensure that his design is successful.

Users want to keep computing costs low and are motivated by a desire to have a product that meets their needs. The data processing professionals are interested in an opportunity to exercise their skills, to demonstrate their capabilities, and to avoid career obsolescence. It is this plurality of interest that must be monitored.

In this process, the manager must always be cognizant of the fact that most errors occur early in the design and development stages, but most of them are not discovered until late in the development process. It is this delay in discovering the errors that creates the cost growth in projects. A manager must work to ensure that these errors are detected as early in the design as possible. This is why users should stay involved and must understand that there are political processes involved that are not always contributing to the development of the ideal system for the user. The quality of the dialogue between the users and the developers determine the accuracy and completeness of the design and is vital to the success of the development effort [Ref. 51].

A special user sub-organization should be established to support the development effort. Additional staff must be hired during this developmental phase, so that part of the normal organization can devote itself to being involved in the development of the new system. This will create a sense of ownership as well as ensure that the design being

developed is what the user needs. This team of people must be removed from the normal line organization [Ref. 52] or they will frequently be subverted in their mission and their perspective by the line organization. A manager must let the user team and the developers do their job. If he interjects himself into the middle of the dialogue between the user team and the development team, it will inhibit the user from expressing his true concerns and needs.

A manager needs to get reports from the team leaders and must remember that meetings where he is getting reports on progress, activities, design, or data must be kept separate from meetings where he is discussing action. The manager who tries to take action immediately on reports will soon find himself getting no information in his reports [Ref. 53: P. 157].

The user team serves as a bridge between the communities of interest. Their role is to encourage other users to identify with the new development while ensuring that the development effort is being molded to fit their needs. A partial rotation of user team membership should occur periodically. This needs to be encouraged by a manager. It prevents the members from getting out of touch with their own organization and the outside world. It also serves to give more users the opportunity to participate, enhancing the user community's sense of ownership of the system.

The team needs to communicate training requirements and also ensure that plans are being made to maintain the system

once it is operational. Users must be especially careful to explain to the designer why the requirements the team has requested are necessary. This will prevent the designers from feeling that the attitudes expressed by the user's are merely capricious. The users must be able to research problems for the designer and test alternatives within their own organizations. In short, the users must become a source of knowledge for the design team.

Last, and perhaps most important, the user team must define the criteria against which the developing system will be measured to ensure that it meets the needs of the organization and will do what it is designed to do. These are the criteria that will be used in the acceptance testing process. Pressman has developed a checklist that the manager can use to assist himself in ensuring that the user contacts are taking place, the process is going on is understood, the different player's roles are identified, and the dialogue between them is serving its purpose [Ref. 56: p. 37].

During this time, a second user team (implementation team) must spend its time developing a plan to bring the system into the organization. They must make detailed plans for every possible contingency in implementing the system. This is not easy for either the user, designer, or developer. But effort spend at this stage will facilitate implementation greatly. If the parties are all aware of what is expected

of them and know what to do when something goes wrong, they can guard against problems in the implementation phase.

B. THE APPROVAL PROCESS

In most organizations, an additional effort must be going on at the same time as development: gaining approval to proceed with the development effort. In government activities this is particularly important. Activities within the Navy are controlled by Navy and Department of Defense regulations.

When the first commercial machine was sold to the Census Bureau in 1951, the market projection was that only approximately a dozen would be sold by 1970. This vast underestimation was to become the first problem for the industry. By 1977 the Navy was estimated to have over 11,000 computers.

As government investment and dependence grew, Congressional concern also grew. This led to statutes in 1965, collectively known as the "Brooks Bill" after Congressman Brooks of Texas. Under this law the responsibility to control the economic and efficient use of automatic data processing in government was divided between OMB for policy, the National Bureau of Standards for uniform standards, and GSA for procurement activity. While the announced goals of this act were considered laudable, many in the industry saw the act as an attempt to prevent a monopoly by IBM.

In the Department of Defense the two basic directives are DOD 1410.55 and DOD 1510.44. The responsible officer

in the Navy is the Assistant Secretary of the Navy (Finance and Management). The basic instructions are SECNAV 5236.1 and 5230.6. These control procurement and approval, respectively. Supporting these are a library of specific instructions at each echelon of command.

The most important fact that a Navy manager needs to be aware of is the dual set of activities required. Separate processes are followed for approval of the system and the procurement activity. An entire bureaucracy has been developed to review proposals, ensure the correctness of plans, and approve the activity.

Because of the continuing changes in technology and Congressional attitudes, a manager is advised to get a current copy of these basic instructions and any other that relate to the project. After a thorough review, the manager should contact the approval authority at the command echelon for advice and confirmation of proposed actions. To know what equipment is currently covered, a copy of the current Navy and GSA definitions and a copy of the appropriate GSA "Schedules" should be requested.

C. SUMMARY

1. The user must provide a design support team of quality employees to work with the data processing department in developing a system.

2. Change and the fear of change are major players in successful systems.

3. The user is responsible for the system developed and must play an active role in the development process.

4. The proper time to form the implementation team is during the designing effort.

5. All systems require management approval.

6. The Navy approval consists of two separate processes:

   a. Approval of systems development

   b. Approval of contracting for hardware or software

7. Navy approval is required by Federal law.

IX. IMPLEMENTATION

A. THE TEAM AND ITS LEADER

The first issue that a manager must face with the implementation is obtaining an implementation leader. The users will need a leader that they trust. The leader must be respected by the supervisors for his knowledge of the operation and his sense of fairness to all elements of the organization. Second, there has to be a plan to support the implementation and a second team of users to work full time as a dedicated staff to support the implementation. This team must have been picked early in the development phase so that they will have had time to start the work and have it accomplished when the system is ready. The team must be sure they understand in detail all of the tasks that the system will require them to do. They will need to be able to identify the skills required to perform these tasks and provide a realistic estimation of the duration and amount of manpower necessary to accomplish them.

The team's tasks should be ordered by what is mandatory, what is necessary, and what is merely nice to have. They need to identify which tasks must be done concurrently, which have to be done first, which can't start until others are completed, and which tasks can be done as time permits. They must also determine how the changes in the organization's

work plan are going to be accomplished with the new work plan. The new organization must be defined, and approval for it obtained from management. Operating policies must be established, conflicts between policies must be located, and the project must be monitored to completion. Specific objectives, procedures, schedules, and work plans must be developed. They must define milestones, arrange to have resources allocated to meet each of these milestones, and make sure these are supported by agreements and commitments from the parent organization. They must have training to be able to accomplish all of this as well as training on the new system. Their plan must identify who in the organization is going to be trained and who will do the training. The team must anticipate all the potential conversion problems and develop alternatives for dealing with them. After all of this is accomplished, the manager is ready to begin his checklist. A typical checklist might look like the following:

1. SOFTWARE

   a. Does it meet all of the mandatory of the original requirements document? If not, where is it short, and is it acceptable?

   b. Which are the "high risk" components (those things which are new, untried, unproven, or which require a high level of skill)?

   c. Does the software have audit trails? Are these trails available and complete? From the audit trails can someone determine who did what and when? (If there is no before-and-after picture to identify the problems and the source then the audit trail is not complete.)

d. Are all the necessary controls, checks, and balances in the system working? Does the system prevent programs from being run out of sequence?

2. HARDWARE

a. Is the storage capacity sufficient?

b. Does the vendor have a support team to help during the implementation stage?

c. Has a plan for a maintenance program been established that is acceptable to the vendor and the operating elements? (This plan should ensure that maintenance will be sufficient so the vendor feels confident that the hardware will work. The maintenance must be scheduled so that it will not interfere with the performance of the work being performed by the operating personnel.)

d. If there are communication links, are all the links in place and working?

3. TESTING

a. Has the testing program been completed?

b. Have all back-up recovery procedures been tested and practiced by the actual users?

c. Have real user personnel been allowed to practice all of their required activities?

4. SECURITY

a. Has the security evaluation been completed? Have all security procedures been implemented and are the users trained to use them? (See Chapter X)

5. DOCUMENTATION

a. Is all the documentation written?

b. Is all the documentation current?

c. Do the user personnel thoroughly understand and comprehend all of the documentation?

d. Are sufficient copies of the documentation available for everyone who has any need for the documentation?

e. Does the developer have a trouble-shooting team ready to assist?

6. FACILITIES

a. Is all the electrical equipment in place? Are there sufficient 110 and 220 volt outlets available?

b. Has the amperage been checked to ensure that there is sufficient amperage in each circuit?

c. If telephones are used, has the PBX been checked? Are all the necessary private lines in place and operational?

7. HEATING AND AIR CONDITIONING

a. Is there sufficient capacity in the system for the normal number of people plus all the new equipment?

b. Is the ventilation accurate and adequate, and is there sufficient air flow to ensure that fresh air is available?

8. OTHER

a. Is all the raised flooring in place?

b. Has static control been implemented?

c. Are the access controls and fire, safety, and security measures ready?

d. Has all the furniture arrived, and is it in place?

e. Is all the conduit and cabling installed and marked on a blueprint?

f. Is there a 30-day supply of material on hand?

g. Has the lighting been checked?

B. THE ACCEPTANCE

Once all of the items on the checklist have been checked and double-checked and everyone is certain that the system is ready, a manager may feel that success is at hand. Nothing

can be further from the truth. Now is the time of greatest potential for failure! No matter how well a manager has executed his plan and followed all traditional procedures to gain acceptance and create a sense of ownership and participation on the part of the user, there may still be full-scale resistance and rebellion.

One method to measure and forecast the potential for resistance is to compare the intentions of individual users and of users versus designers [Ref. 54]. When everyone has similar intentions there is less likelihood for resistance. The more diverse their intentions, the greater the likelihood for resistance.

This resistance traditionally starts from an argument over efficiency versus effectiveness of the design, the location of the system, or the elements of the system. In reality the issue is political. By changing access to information, by redefining what information is available or who has access to information about other parts of the organization, a new system can threaten and change the power structure in the organization.

A project manager needs to be aware that, even if he has performed all the traditional rituals to gain system acceptance, he still has to ensure that he has not upset the power balance in the organization. The only way to be sure that there will be no upset of the power balance is to make sure that management is fully supporting the project or

manager or that the system fits the existing power structure. A manager can reduce the risk of resistance by designing the system to fit the existing power structure or by having the organization support him in redefining power within the organization. The last thing he wants to do at this point is renegotiate. To negotiate now will weaken the design of the system. The choice of working with or defing the organizations' power structure should have been made early in the definition stage, and it is too late to compromise now. Implementing the system now will be much easier than trying to negotiate the power structure.

C. THE START-UP

During the start-up period, many unexpected things can happen [Ref. 51]. To counteract this, extra resources will be necessary; extra operating staff, maintenance staff, and technical staff must be made available. Extra equipment, spare parts, and material must be available because when people are learning there is the potential for break-down of the equipment. People who are learning a new skill make mistakes. All of these extra resources require extra budget and extra time.

The organization during this start-up period will be different from normal. The design team will still exist as will the user working group, but now the implementation team is in the foreground. Its members must be able to exert

an influence within their respective organizations, and they must be self-initiators, problem solvers, very knowledgeable in the operations of their organization, and able to look at the big picture. The members of the implementation team must be removed from the control of their original supervisors and allowed to devote all of their working hours to this project, without having to worry about the work they left behind.

Building such a team is the job of the implementation team leader. The manager then uses that team to teach the parent organization about the new system and the roles of the individual members. The implementation team must receive exhaustive and detailed training. This training takes time; therefore sufficient time needs to be available before the implementation begins. In fact, the start-up team should be used as guinea pigs in the development process. They should be the ones to find out if the screens do not look right or if the documentation procedures are understood as drafted. This "guinea pig" role gets them up on the "learning curve" faster than if they are taught about the system after completion.

During the start-up time, line management must accept a temporary loss of prerogatives. Its ability to influence and control the activities of the organization cannot be allowed to interfere with the activities of the implementation team. The appropriate management style to accomplish the

start-up is a supportive one. Only after the implementation has been completed and the system declared operational should the management style be allowed to return to whatever is traditional for the organization. The start-up team will need to be able to use conflict management within their own team to resolve problems. They must accept conflict among themselves, resolve it, and set a course, because there is no time for any other approach.

A "stress monitor" needs to be associated with the implementation team, but not part of the team. The stress monitor will be able to tell the team leader to "back off" when he is pushing too hard or to provide encouragement to the team when they are getting ready to give up. This stress monitor can act as liaison between the team leader, the project manager, and the parent organization. This will protect the team leader and the project manager from intense grilling by the line management. All parties need to be informed of what is happening, but getting information from the team leader and the project manager only adds an extra burden, one that the stress monitor can perform equally well. Secrets at this stage cannot be allowed.

D. DATA CONVERSION AND COLLECTION

The third major element during implementation is the conversion and collection of data. Additional staff, either in-house or contract, will be necessary to help support this

[Ref. 53: p. 174]. Whether it is done by terminals, batch processing, or computer conversion, there will be a tremendous workload associated with converting existing data to fit the new system. There are some basic rules associated with the collection of the new data that will be available with the new system. Do not scroll forms; use multiple forms instead. Keep forms simple. Avoid clutter. Display things logically. Use English language commands. Avoid special spellings and terms. Data processing can be more accurate, more cost-effective, and more reliable, but it is far less forgiving than manual systems.

Source data entry -- the one-time capture of data at the initial source -- is cost-effective and is much more likely to provide accurate information. It is the users at this point in the organization that knows the most about the data they are entering [Ref. 10: p. 220].

The turnover of a new system to the users should be a show. Announce the new system and glorify it. Show everyone how it works, show the complete documentation, show how to request changes, show how to evaluate its performance, show how to improve response time. If this information is not provided to the users and provided at the beginning, even good systems can fail.

E. SUMMARY

1. Picking a trusted member of the organization to lead the implementation team is a vital step.

2. The implementation team will plan the process, monitor the progress of the development, perform the acceptance tests, and recommend when the system is ready for conversion.

3. Acceptance will largely rest on the impact the design has on the organization's power structure.

4. Start-up will be a period of high stress for all participants and must be monitored carefully.

5. Data is a major element of implementation, and because of the volumes involved will require extra people to process.

X. SECURITY

A. PROTECTION

While security is a housekeeping function, it is of significantly greater importance than most, and it warrants separate treatment. Questions to be considered are:

1. How secure is the computer?
2. How is it vulnerable?
3. What would be the cost if the computer were non-operational for a period of time?

It is actually management data, not the computer, that is in real need of protection. It has been suggested that only 15% of the crimes involving management data are ever discovered.

The potential threats can be met [Ref. 57]. Answers include internal control, managing and separating duties, physical and administrative controls, locks, off-site duplication of data, and training and qualifying a staff that is not bored or prone to excessive errors. System software and application software should not be accessible to the casual user. Methods of communication security include terminal identification, encryption and passwords, and post processing or record reviews of who did what. Interactive processing, however, poses problems for which no solutions have yet been devised.

A recent American Bar Association survey of 283 companies and public agencies found that 25% had suffered known and verifiable losses amounting to as much as $730 million dollars due to computer crimes during the past year. Based on this and other studies, authorities have estimated national annual losses at approximately three billion dollars. One expert says [Ref. 58]

> Bonnie and Clyde were in the wrong business. The average bank robber nets $20,000. If caught he has a 90% chance of being prosecuted. If convicted he is apt to get up up to five years. The thief who pulls off an electronic funds transfer nets an average of $500,000, has a 15% chance of prosecution, and if convicted faces only about five months behind bars.

One definition of computer security is "protection from unlawful or unacceptable actions or events affecting the computing assets, i.e., the assets of the computer complex and the information or data processed and or stored by that complex." [Ref. 58]. This definition includes not just illegal, but also unacceptable, acts, such as mistakes caused by lack of proper procedures or training.

Computer security involves the assets of the entire complex, the value of lost machinery or hardware, and the time it takes to repace it. Software and documentation are virtually irreplaceable unless copied somewhere. People are normally safe in the computer environment, but, in the event of a fire smothered by carbon dioxide or similar agent, people need to be protected from the extinguished agent.

Unacceptable or illegal acts are defined in six categories:

1. Destruction of data. The information is often tampered with for personal gain. Fraud is very easily perpetrated but very hard to detect.

2. Interruption of service for prolonged periods of time.

3. Inadvertent release of proprietary or personal data including Privacy Act violation.

4. Theft of software, data, or documents.

5. Natural or physical causes, including fire, flood, earthquakes, and power failure.

6. Equipment failures.

A security plan including procedures to prevent all of the above problems should be devised and implemented. Procedures should be tested to detect failures. There should be contingency plans in case the prevention or protection measures fail. Critical systems and components should be defined and a means to replace them or temporarily operate by an alternative means or in another location should be established.

The manager needs to remember that the computer is innocent; it will reveal anything it knows if asked in the right way [Ref. 60]. Modern dispersed, or distributed, systems cannot be locked up in a room in the way that earlier systems were. Steven Walker, a consultant in the Department of Defense, suggests that we need to be able to get trusted systems (secure systems) from manufacturer's without having to order a system specifically designed. Increased use of

distributed systems clearly raises problems of authentication of users. Current methods rely on easily obtained tokens, either physical or ephemeral, such as passwords or protocols. In some ultra-sophisticated systems we are using combinations of voice patterns, eyeball patterns, and palm prints for identification. In the future, we are going to have to rely on easier-to-use but more stringent means such as signature authentication.

A recent study done for IBM [Ref. 61] found that, for 248 users of the signature system being tested, the system failed to accept less than 2% of the valid signatures and failed to reject less than 4/10 of 1% of the invalid signatures. Clearly, this is not adequate for our security systems yet, but it is getting close. Many commercially available sytems will provide the level of security needed in the normal routine business system.

B. COMPUTER CRIME

Computer crime is probably getting the most attention in the computer security area. However, it is the protection of assets such as hardware, software, and data that is most often at stake. HR-192, introduced by Representative Bill Nelson of Florida [Ref. 62], would make it a crime to illegally access or damage a Federal computer. It would also make it a crime to use or attempt to use a computer with the intent to

execute a scheme or defraud or obtain property by fraudulent pretenses. It would also be a crime to intentionally damage a computer covered by the act or intentionally deny the owner access to the computer or computer-stored information. The penalty would be up to five years in prison or a fine of $50,000.

The legislation goes on to define a computer as an electronic, magnetic, optical, hydraulic, organic, or other high-speed data processing device performing logic, arithmetic, or storage functions. New language in the bill also includes in the definition any property, data storage facility, or communication facility directly related to or operated in conjunction with a computing device. Knowingly submitting false information to a computer operator would also be a crime. This legislation excludes hand-held calculators and home computers that are used exclusively for routine personal, family, or household purposes. It excludes automatic typewriters for typesetters. If the user dials up another computer from his home computer with criminal intent then he stands in jeopardy. This would go a long way toward solving the criminal aspects of computer security, and used in conjunction with security plans for physical protection it can provide a comprehensive security plan.

Master Sergeant Alfred Foster, from the Security Office for the Air Force, recently provided a list of how computer fraud, waste, and abuse are committed [Ref. 63]. He suggests

that the greatest threats are ADP auditors, system computer security managers, data base administrators, and managers, because of the amount of knowledge they possess. Great threats come from computer operators, data entry and up-date clerks, operations managers and supervisors, and systems programmers, systems maintenance personnel, and programming managers and supervisors. Limited threats are communication technicians and engineers, janitorial and maintenance personnel, magnetic media librarians, functional area media librarians, and terminal maintenance personnel. The typical computer criminal or abuser, in addition to working in one of the above-listed positions, generally has been found to fall in one of three categories:

1. He is between 18 and 46 years of age (average age, 25).

2. He is among the most highly skilled and highest performing technicians in his field.

3. He is generally overqualified for his position. An overly qualified employee tends to become frustrated and bored, which leads to searching for ways to better utilize his skills. Nearly 75% of all offenders have been highly experienced professionals, and almost 50% of that number were in managerial positions. In most instances, the offenders committed their crimes while engaged in their regular duties. Here is how they do it:

    a. They manipulate data by changing the code in the regular computer instructions, which causes the computer to do unauthorized things when certain conditions are met.

    b. They take very small bits of assets from a large number of sources or accounts and transfer them to another one.

c. They add instructions to a program that will cause the computer to perform abnormally or malfunction.

d. They add special instructions that interrupt the routine capabilities of the program and cause it to do things other than were planned.

e. They place in the code what is called a "logic bomb," so that when a certain set of conditions is met the computer will suddenly erase its memory.

f. Some perpetrators scoop up information found in trash cans or carbon papers left behind after a job has been executed or remove data or copies of data from the completed job.

C. PREVENTION

Almost all computer crime can be stopped with a few simple precautions.

1. Passwords should always be more than 4 letters or characters long. This makes the possible combinations so large that it is very difficult to guess the correct one. Passwords should be changed immediately upon suspicion that someone has obtained access to a password either unlawfully or inadvertently. Passwords should be changed at least every six months. They should have no meaning connected to their owner; serial number, social security number, names of relatives, families, or pets should be avoided.

2. Computers can be programmed to deter a penetrator by slowing him down and causing him to wait a period of time if he makes a mistake inserting his password. This can be frustrating to the honest user who makes a mistake but requiring the penetrator to wait five or ten seconds between each attempt foils automatic high-speed dialing devices that are now being used to come up with the codes. The caller can be limited to three wrong guesses, then forced to start over. Computer records showing the time the attempt was made and the result of every attempt should be kept. Such logs can reveal patterns of calls that may help track the penetrator down. In some cases it may be appropriate to prevent remote telephones from dialing into

the computer. If the computer receives a valid identification, it can be programmed to hang up and dial the proper telephone number for the authorized user of that identification. A secure computer should not inform the caller that he has made an invalid access attempt. In fact the ultimate form of security is to prevent anyone from outside the system to dial into it.

3. As another measure the computer owner can program his system to trace telephone calls and record where they came from so that after making several erroneous attempts, the police can investigate whether the person had any authority to make the call in the first place.

4. In the government, especially the Department of Defense and the Department of the Navy, security has more stringent aspects. The Navy's security program is oulined in OPNAVINST 5239.1A. The latest version is dated 3 August 1982. This document provides all the details about the Navy's security program for automatic data processing, except for local procedures for implementation, It applies to all Navy data processing except contractor-owned and operated or contractor-controlled systems on non-government premises. (These fall under a separate set of instructions dealing with security of industrial contracting). The instruction encompasses all data-processing security for the Department of the Navy except for certain high-level requirements that are outlined primarily by the National Security Agency. It covers physical, administrative, and operating procedures, personnel, communications, emanations, hardware, software, and data. The instruction applies to data-processing activities and office information systems or networks. Data-processing activities are defined as organizational entitites responsible for developing, operating, or maintaining a data-processing system or network.

Office information systems are defined as the application of automated technology for document preparation, storage, retrieval, manipulation, and distribution in an office environment. These have separate security requirements from other automated data processing systems. The minimum requirements for all automated data processing are that:

1. It will be protected by a cost-effective security program.

2. It will have environmental, physical, and contingency plans. Environmental plans cover temperature and humidity, lighting, electrical equipment, cleanliness, precautions against water damage, fire safety, and smoke detection. Physical protection includes barriers, access control, data access, and natural disasters.

Obtaining accreditation for a data-processing activity involves collecting and analyzing data for approving authorities. The Auditor General of the Navy is responsible for conducting internal audits for the Navy of all security plans. The Controller of the Navy is responsible for reviewing and approving financial systems. The Commandant of the Marine Corps is responsible for all Marine Corps systems. Commander, Naval Data Automation Command, approves classified systems. For any special systems dealing with classified materials see the instruction itself for specific information.

The Commanding Officer of each activity has basic responsibility for security of data processing in his command and will have a security officer appointed to support it. If an individual activity is not accredited, it may have interim authority to operate for a fixed period of time, contingent upon certain prescribed conditions. An accreditation is good for up to 5 years, provided that there are no hardware or software changes and that there is no modification to the facility, and no security violations revealing flaws in the security plan. Office information systems must also be protected, since they are considered a subset of automated

data processing. The automated data processing security office appointed by the commanding officer will supervise security for office information systems. The minimum level of protection in this area is physical protection, as in automated data processing. Frequently the locked office with the normal protection for government offices is considered sufficient, provided there is also a contingency plan.

Each activity must implement a risk-assessment program to determine how much protection exists and how much is required. All new risk assessments initiated for systems after August 1983 must conform to this new instruction. Appendix E of the instruction provides details on conducting the risk assessment program, which must be conducted every five years, or sooner if changes in the system occur. A security test and evaluation must be conducted for each accreditation to determine if the countermeasures of the plan are installed and if they are working effectively. This will provide the information necessary to support the designated approving authority's decision on accreditation.

The foregoing is not a complete summary of the security program, but only highlights some of the things that must be done in order to have a properly secured system. For the most part, the manager of any project is not in a position to conduct the security program by himself; he must rely on the technical expertise of the development team to support

a security plan for the system. The manager should therefore concern himself with seeing that the plan is developed and that the accreditation of the system is obtained so that it can be made an operational system. It is this author's advice that COMNAVDAC personnel be invited to participate in the development.

In addition the Federal Personnel Manual, OPNAV 5501.1 requires a special security investigation of all personnel with access to the system. These instructions are currently being held in abeyance but could be implemented at any time.

D. SUMMARY

1. Security warrants special attention as a separate subject.
2. Security means protection of data, hardware facilities, and software from willful or accidental damage and inappropriate disclosure.
3. Aspects of security include protection of data, hardware facilities, and software from willful or accidental damage and inappropriate disclosure.
4. A profile of people likely to cause problems is available to the manager.
5. Government and Navy activities have special programs to validate proper security precautions.
6. Special security clearances may soon be required of all Navy personnel with access to information systems.

XI. OPERATING THE SYSTEM

A. MAINTENANCE

Operating the system is primarily a matter of maintenance, which breaks down into two parts: the maintenance function itself, which could more aptly be called housekeeping, and the organization to perform these services. Both are critical; in fact, given a normal life of about eight years, the cost of this effort will exceed the development costs by approximately 50%. If the life of the system is extended much beyond the normal eight years, the cost of using the sytem may well be double that of the development costs.

Maintenance of hardware means taking care of the equipment in a scheduled and routine manner to ensure that it performs properly. A manager should make sure that the schedule for maintenance does not interfere with the schedule for supporting the users. Maintenance of the system software is usually provided by the same vendor who provides the hardware. This normally consists of making changes in the operating system to solve problems discovered since the operating software was provided. Part of these changes are a conscious evolutionary program on the part of the vendor to move from one set of capabilities to another so that the transition from the current set of hardware to a new set of hardware will be much easier using the vendor's equipment.

This is a part of a marketing program and may not be beneficial to the user. Therefore, discretion needs to be used in determining whether to go along with proposed vendor changes or to keep the software static. It is largely a question of whether the user considers it advisable for the system to evolve or remain as is, which in turn depends on the type of applications being supported.

Far and away, the largest portion of the maintenance effort, though, is supporting the user's system or the application software. This is one of the biggest expenses that will be incurred in the life cycle of the application. There are three general categories of this kind of maintenance.

Approximately 25% of the effort will be in correcting errors in the original programs that resulted from misunderstandings or misstatements of requirements. About 25% will be in adaptive efforts to change the system because requirements have been changed by outside forces. For example, there could be changes in the tax law that would result in changes in the way payroll is computed. The remaining 50% is mostly enhancement. These are changes that are discretionary, but will frequently pay tremendous dividends. On the average, 70% of the programming staff at any data-processing organization will be devoted full-time to doing software maintenance. This is one of the primary reasons

why there is so much reluctance and resistance in ADP management to changes. They are swamped with changes.

Why is all this change necessary? Lehman describes it in a series of laws. He suggests that

1. There is a continuing change in the environment that a program operates in, and thus either the program is changed in order to keep up with its environment or it becomes progressively less useful.

2. As these changes are made to the program, the original design plan begins to deteriorate. Modifications made here and there gradually destroy the dynamic design of the program.

3. There is a rate of change that can be sustained in any program and if you try to change the program faster or put more changes in the program than can be absorbed at any one time, it is going to induce more errors than it does correction.

4. There is a tendency to assign programmers to "help" on a project because they have a coupld of days free, which does not add anything to the successful program. There is a limit to the amount of change that can happen to a program. The content of successive changes or releases of an evolving program is statistically invariant, and beyond a certain amount of change a major redesign becomes necessary either to rewrite the existing program or write a new program.

What kind of control should we have on this maintenance? Obviously there has to be a change-control procedure. A users group should review proposed changes and decide whether they are affordable and whether the benefits exceed the cost. This group may be from management and called a steering committee. Maintenance changes should be done on a planned schedule and not haphazardly as the programmer happens to get done with a piece of coding. There should be a separate

maintenance staff. There should be an effort to recognize that in reality the maintenance programmers are more critical and more important to the successful operation of the organization than are the "glory boys" doing the new work.

Actions can be taken to minimize each of the three categories of maintenance.

1. Corrective maintenance can be minimized by following a good design plan. Data Base Management Systems help minimize change. Using the same logic in more than one program helps. Using high-level languages such as Cobol and Fortran instead of assembly and machine languages also helps. Structured programming, defensive programming, and maintenance audits are all techniques the programmer can use to reduce the need for corrective maintenance.

2. Controlling adaptive maintenance is principally a matter of knowing what the system does, having fully documented programs, and carefully deciding when and why to act.

3. Protective maintenance is a matter of using a prototype for testing to be sure of what you want to do before you do it. Keep user documentation up to date and provide user training. (Often, changes suggested to a program are made because the user does not know its existing capabilities.) Change-control procedures, charging users for changes, and using a scheduled maintenance plan all help reduce the cost of these efforts. Factors which tend to drive up the cost and the amount of maintenance effort are system age, size, program complexities, number of reports, and poor documentation.

Documentation comes in different kinds, sizes, and shapes and for many different purposes. Documentation should include the operating procedures in the computer center itself. What is to be done, when, and why, particularly in emergencies? Documentation should also include data entry procedures, and

how the users use the system, what they can obtain in the way of reports, and what information is provided by the system. This information is useful in the area of training also, because documentation for the user becomes the backbone of any training program.

Training has to continue after the installation. Some people do not receive the training during the installation for one reason or another. Training has to be provided for new users when they come into the organization. Retraining of existing users is necessary periodically to ensure that they continue to use the system properly. Retraining is also necessary whenever changes are made to the system.

Configuration control means keeping the system stable the way it was originally before changes were proposed and keeping track of approved changes and progress in implementing approved changes. Any change can affect the system and must be done carefully, with forethough, planning, and thorough testing to make sure that it does not impact and interrupt support to the user. A team of users and members of the data processing community should discuss and evaluate all proposed changes. Once these changes have been approved by management, based on the team recommendation, there should be a formal means of tracking their status and ensuring that they are thoroughly evaluated and tested. A set of written procedures should be drafted for everyone involved in the system, and these written procedures should describe how

changes are suggested, reviewed, evaluated, and approved for implementation. The actual implementation of each change should be a miniature process in parallel to that which was done to implement the whole system.

Reliability is covered in a document called "The Federal Information Processing Standards, Publication 11-1." It provides data-processing personnel with criteria as to what is reliable and how to measure reliability. It deals with the probability that the system will be available when it is needed and will do the job it was intended to do when it is desired to have it done.

B. THE ORGANIZATION

The housekeeping organization for an information system should look something like figure 5. In this organization the individual data bases and their operating systems can report either to the data administrator or to the functional organization. It is the opinion of this author that it is better to have the individual database administrators report to their functional managers. This will greatly complicate the data administrator's life but will maintain the service orientation of the data base administrator towards the functional area that they are supporting.

The information systems manager has overall responsibility for the three techniques that are coming together in the modern office to support its operations: communicators, word

processing, and data processing. His role to ensure that all the equipment can communicate and that a common language is used throughout the system. The information system manager or resource manager must understand the organization and be attuned to its mission and its objectives. He must be sensitive to the ethics and personality of the organization and must understand the interpersonal dynamics of the organization. The individual must have credibility, must understand the needs of the users being supported, and must avoid all appearances of empire building. He needs to be a mature, politically astute individual respected throughout the organization.

The data administrator's role is similar to that of the data base administrator; however, his perspective is on the total organization and not toward any one functional element. His role is oversight of the data base administrator in their relationship to the total organization. He must maintain the master data dictionary for the organization. He is the key to gaining many of the benefits so often promised and not delived by data processing. He must also be politically astute and able to work well with people throughout the organization.

The individual data base administrators supporting their individual functional areas are responsible for establishing each data base, maintaining it, controlling the expansion and deletion of data, detecting and correcting errors, editing

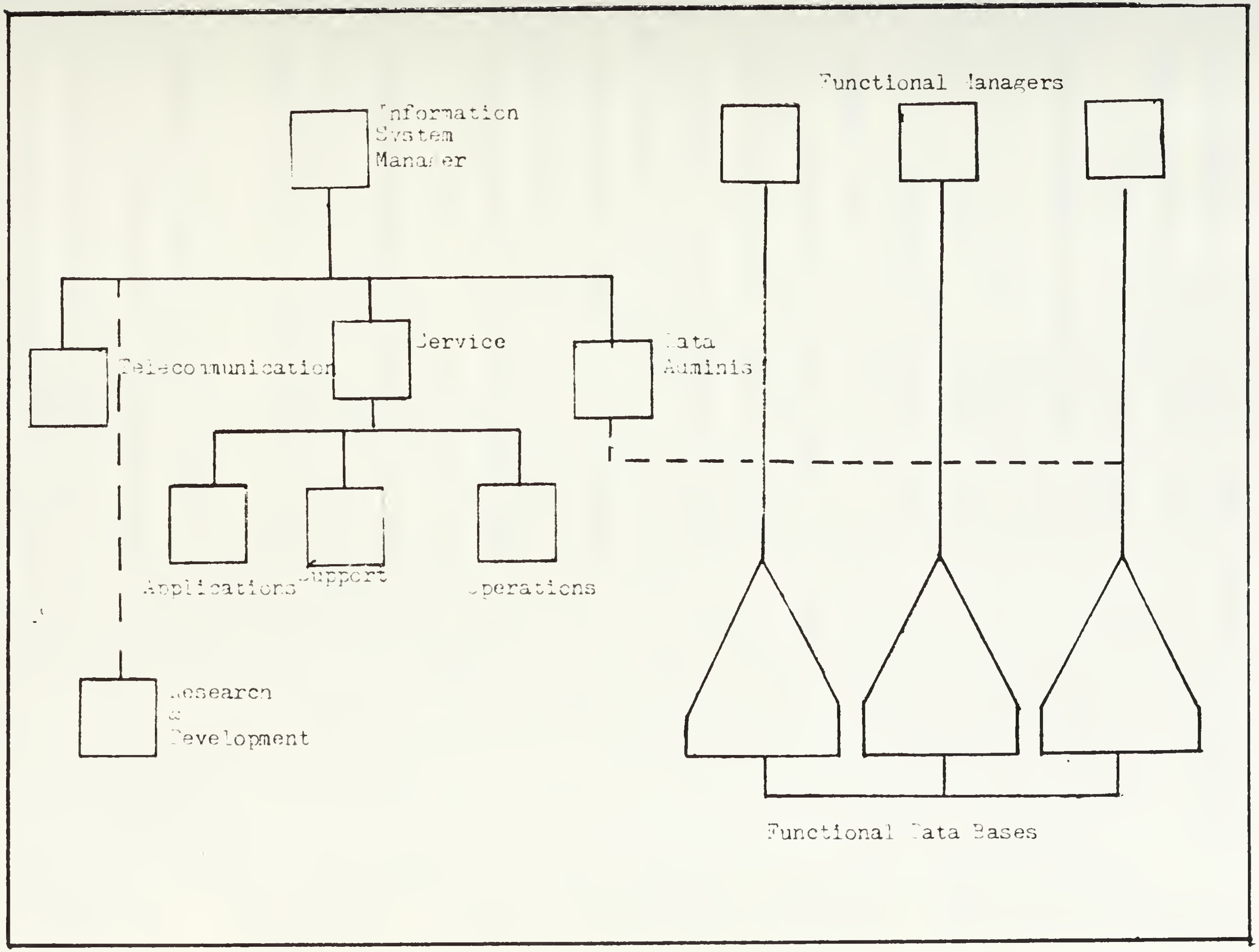

Figure 5. Support Organization

data, providing retrieval capabilities, and assisting the user. He must maintain security, maintain a recovery capability, manage the system analysts and the application support programmers, coordinate with the user, maintain the data base management system itself, and monitor the performance monitoring of the data base.

As commercial packages and centrally designed systems are used more within the Navy, the role of the data base administrator is going to be complicated by the problem of responding to the external design agent. He must maintain an understanding of the technology as well as the function for which he provides the support. He is responsible to the data administrator for coordination, interface connection, and standards commonality with the rest of the organization. He is responsible to his functional manager for providing the service and support that entity requires, and he may be responsible to an external design agency for maintaining uniform standards between his data base and other data bases at other locations supporting the same functions. This is virtually an impossible task.

The data base administrator will have analysts, programmers, and operators working to support his data base. His most senior senior analyst will gather facts, analyze the problems of the user, assit the user in defining needs and preparing requirements documents. These documents must be

understandable both to the user and to the programmer responsible for preparing the response.

Programmers convert the senior analyst's design into computer code. Some senior programmers may do limited analsis. A senior programmer should have an analytical mind and exhibit attention to detail, the drive to complete a job, patience, and perseverance. A university background is not required. Many good community colleges and trade schools provide equal or better preparation for computer programmers than a four-year college education.

A user representative primarily concerned with problems in dealing with the data base is required. This representative needs to have a thorough understanding of the data base and its contents to fulfill his role as a liaison between the data base and the user community. A large data base, if it is not centrally designed, may also require system programmers who have responsiblity for supporting the data base administrator in his role in monitoring and fine tuning the data base design.

In the Federated approach, operation of the computer system may well be contracted to a computer center, the operations center, shown in figure 5. This relieves the functional manager and the data base administrator of many of the mundane housekeeping chores related to hardware maintenance. These contract operators work for the data base administrator but are more efficiently administered

by a central organization providing a pool of talent to support the various data bases as required.

Alternatively, this same contract system could be employed for the documentation library of the individual data bases or, if warranted by the size, complexity, detail, and volume of the data bases, they may be assigned to the data base administrator's staff as full time personnel.

The organization is responsible for the computer system's communications network. An organization cannot afford competition between communication systems; therefore, there must be one communication system for the organization under the responsibility of the information systems manager, designed and supported for the entire organization. Under this individual there may be telecommuncation analysts, electronic engineers, and contract specialists.

The service element of this telecommunications organization is composed of three parts: computer center operations, a support group, and an application group. The computer center operations group will be responsible for operating a central computer if one is maintained by the organization. Given the Navy's current move toward individual computers and individual DBM systems for functional areas, it may be responsible for maintaining the operations of those individual computer operations as well. The computer center should contain operations personnel to run the hardware, an applications documentation librarian who provides copies of the

application programs to the programmers for maintenance when required. The documentation librarian must ensure that all documentation is changed before implementation of any program changes in the application library. If a data or tape library is maintained also, a librarian is required to maintain them as well.

The support organization is responsible for providing maintenance services to the Information Systems Manager for the entire inforamtion system and all the users of that system and its components. Centralized contracting for support from various vendors for maintenance efforts is frequently considerably cheaper than individual service calls. The support organization should have a facilities manager responsible for routine functions such as air conditioning, electrical supply, raised flooring, and secured doors.

The ADP security officer may also be located in this support group. This individual should be experienced in training, to provide continuing education opportunities to the members of the information systems organization and to the user community. Someone with an understanding of human factors should be included in the staff. A statistician may be assigned to the organization, and the responsibility to maintain standards may well reside in this position, in order to insulate the position from the influence of the various organizations that must comply with the standards.

The third element of the service organization is applications, responsible for programming support. The applications organization should be composed of three types of personnel: analysts, programmers, and a metrics or verification and validation group. The metrics group primarily is used to track and estimate costs of development. It also oversees the testing, verification, and validatiaon of individual products.

Some organizations are sufficiently large that a research and development group is resident under the information systems manager. This evaluates new software, equipment, and concepts and may also be the focal point for prototypes and projects for the future. In less technically advanced organizations this group may be separated from the information group and placed under the protection of a senior official to challenge the regular organization to try new technology.

C. SUMMARY

1. The cost of maintaining an information system usually exceeds its development cost.
2. Maintenance includes taking care of the system to prevent or fix problems.
3. Maintenance covers hardware, software, documentation, and data.
4. Software maintenance is correction, change, or enhancement to prolong the useful life of the system.
5. Seventy percent of most data processing organizations is devoted to maintenance.
6. The information system organization must be designed to support this effort.

XII. CONCLUSIONS

A. RESPONSIBILITY

It is the responsibility of the management of the functional element of the organization converting to the automation to actively oversee the entire project. Responsibility for technical effort in support of the project can be delegated to the data processing organization but even this aspect must ultimately remain the reponsibility of the user organization.

The user organization has the necessary resources and the people who understand the complexities of the problem. They are the poeple that will benefit from or be subjugated by the system.

Data processing is a technical tool that can facilitate the operations of an organization. The data processor knows how to use the computer but not how to perform the operations that are the mission of the user organization. An organization designed to provide the necessary support for the information system must be instituted. This organization first and foremost must be responsive to the requirements of the organization. It must support the system while remaining technically competent and professionally aware of its responsibilities.

B. MAJOR PROBLEMS

The most important issues that the project manager faces are found in the user organization itself. Any disruption in how the individuals and components of the organization perceive their relations with others in the organization can have an adverse impact on the implementation of a new system. Resistance to change is deeply engrained in individuals and in organizational behavior. To overcome this resistance a number of strategies are available to the astute project manager. These tools should be employed actively and continually throughout the life of the project.

The project manager must concern himself with the well-being of the people in the organization. The physical environment in which they spend a major portion of their life must be designed to support and encourage the performance of their jobs. The job itself must be a desirable activity that will provide the psychological and sociological incentives to encourage the employee to provide quality service to the organization. The environment should be free of physical and psychological hazards. The manager needs to be concernted with the how the health of the employees may be affected by the system. Furniture that promotes well-being, properly designed lighting, adequate protection devices, and accepted work procedures and rest periods need to be ensured.

The very newness of much of this equipment and the lack of knowledge of its long-term effects on the employees require a vigilant, sympathetic concern on the part of management.

The fears and concerns of employees about change, the future of their jobs, and their relationships with their peers must be heard and addressed by the project manager. Jobs need to be structured to meet the needs of the individuals involved as well as the goals of the organization. Care should be exercised in changing the content of any job to be sure the change improves the perception of the quality of work life for the individuals involved.

The third major concern of the project manager must be the technical aspects of the effort. The design of the system must meet the needs of the organization in a technically feasible manner with a minimum of risk and cost. To accomplish this part of the mission, the project manager has available to support him the professional staff of the data processing organization. The primary task the manager must carry out is maintaining control over the project and the data processing staff to ensure a timely, cost-effect product designed to meet the needs of the organization.

APPENDIX A

CHECK LIST OF ACTIVITIES

A. Prior to contacting Data Processing

1. Have the real problems to be solved been defined and researched?

2. Have the people concerned been talked with?

3. Have the reasons for the current procedures been researched and documented?

4. Have all possible alternative solutions been identified?

5. Have previous methods been looked at?

6. Have other organizations with similar functions been looked at?

7. Have all constraints on the current system been verified?

8. Have all bottlenecks in the current system and their sources been identified?

9. Have all the interfaces with other systems been defined?

10. Have all organizational elements using the system been identified?

11. Have the consequences of change for other organizational elements been identified?

B. Feasibility Study

1. Have the goals of the study been defined?

2. Have the boundaries of the study in time, money, organization and subject been defined?

3. Have users and business analysts to do the study been identified and assigned?

4. Has the current system been documented?

5. Have viable alternative solutions been documented?

6. Has a recommended approach been identified?

7. Has data processing provided a detailed critique of the proposed solution?

8. Has a preliminary cost and benefit analysis been performed?

9. Has a risk assessment been developed?

10. Have any partial solution subsets of the proposed solution been identified?

11. Have all the consequences of the proposed solution or subsets been identified?

12. Has management been provided a report of the study and recommendations?

C. Data Processing Effort

1. Has a development contract with data processing been written and a fixed cost agreed to?

    a. Are the requirements defined?

    b. Are the times defined?

    c. Are the people, users and data processing defined?

    d. Are the products of the contract defined?

    e. Are the responsibilities defined?

    f. Have commercial products been reviewed?

2. Do plans to be provided include:

    a. Software specification and documentation

    b. Software configuration management

    c. Software quality assurance

    d. Software verification and validation

e. Software maintenance

f. Software acceptance test

g. Software implementation

h. Software operation documentation

3. Hardware Procurement

   a. Hardware configuration

   b. Hardware acceptance

   c. Hardware implementation

   d. Hardware maintenance

   e. Hardware operation documentation

   f. Facilities requirements

   g. Security requirements

   h. Training program

   i. Data conversion and collection, data backup and recovery

   j. Related office procedures and desk procedures

4. Are Project Controls and Reporting Requirements Defined?

5. Has a Steering Committee been appointed with a mission and charter defined?

6. Have user training and operating manuals been provided for?

7. Have all interfaces been defined and responsibilities established?

8. Has a data dictionary been provided for?

9. Have system acceptance and implementation procedures been provided?

10. Has a maintenance staff been planned for?

11. Have user representatives been assigned and their role defined?

12. Are formal design and development reviews scheduled?

D. Office Environment

1. Has all existing space been inventoried?

2. Has all existing equipment been inventoried?

3. Has all existing furniture been reviewed for suitability or replacement planned?

4. Have plans for remedial action on all deficiencies? been developed?

5. Has the lighting situation been checked:

   a. Control of natural light

   b. Control of artificial light

   c. Control of reflective light

6. Have work spaces been checked:

   a. Adequate and proper light

   b. Adequate heating and cooling

   c. Adequate airflow

   d. Adequate space including proposed equipment

   e. Adequate sound control

7. Has all equipment been checked for adequate sound control?

8. Have rest areas been provided?

9. Has the electrical supply been checked by individual circuit for adequacy?

E. Organizational Environment

1. Has user involvement been built into the project?

2. Will organizational restructuring be necessary?

3. Have plans been prepared to share this data with all the parties involved?

4. Have plans been prepared to mitigate any adverse impacts to the change?

5. Has the existing power structure (formal and informal) been identified and planned for?

6. Have new procedures been developed where changes are contemplated (down to the desk level)?

7. Have training and trainers been identified?

8. Have manning levels for implementation and operation been prepared?

9. Have recruitment plans for extra staffing, if required been developed (prior to the time needed to allow training)?

F. People Aspects

1. Are the people informed about the project (has the rumor mill been controlled by information)?

2. Are the people regularly updated on the project?

3. Does a vehicle exist to answer questions in a non-threatening environment?

4. Are any special problems that may require special consideration accounted for (bifocals, wheelchairs, etc)?

5. Have the people been informed about their employment future?

6. Have plans for people unable or unwilling to make the change been prepared?

7. Has a stress monitor been provided?

G. Resources

1. Has management provided the additional manpower

   a. To cover the user development team

   b. To provide for the implementation team

c. To provide additional personnel, during training and implementation

2. Has management provided for the facilities adaptations?

3. Has management provided for the equipment needed?

4. Have user personnel been assigned to the project fulltime?

5. Has data processing personnel been assigned to the project fulltime?

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